SGM8954-1/SGM8954-2
High Precision, Low Power, Rail-to-Rail I/O, CMOS Operational Amplifiers

GENERAL DESCRIPTION

The single SGM8954-1 and dual SGM8954-2 are low power, high precision CMOS operational amplifiers, which can operate from 1.8V to 5.5V single supply or from ±0.9V to ±2.75V dual power supplies, while consuming only 9μA quiescent current per amplifier. The SGM8954-1/2 support rail-to-rail input and output operation. The input common mode voltage range is 100mV beyond the rails, and the output swings within 5.5mV of the rails.

The SGM8954-1/2 feature high impedance inputs, a 35μV maximum input offset voltage and zero-drift over time and temperature. These devices are designed to provide optimal performance in low voltage and low power systems. Meanwhile, the SGM8954-1/2 fit in tiny packages. These specifications make the operational amplifiers appropriate for a wide range of applications requiring high precision, such as driving ADCs with high linearity.

The SGM8954-1 is available in Green SOT-23-5, SOIC-8 and UTDFN-1.6×1.6-6L packages. The SGM8954-2 is available in Green SOIC-8, MSOP-8 and TDFN-2×2-8L packages. They are specified over the extended industrial temperature range (-40℃ to +125℃).

FEATURES

- **Low Offset Voltage: 8μV (TYP), 35μV (MAX)**
- **Low 0.1Hz to 10Hz Noise: 1μV_{P-P}**
- **Unity-Gain Stable**
- **Gain-Bandwidth Product: 110kHz**
- **Integrated RFI Filter**
- **Rail-to-Rail Input and Output**
- **Support Single or Dual Power Supplies:**
  1.8V to 5.5V or ±0.9V to ±2.75V
- **Quiescent Current: 9μA/Amplifier (TYP)**
- **-40℃ to +125℃ Operating Temperature Range**
- **Small Packaging:**
  SGM8954-1 Available in Green SOT-23-5, SOIC-8 and UTDFN-1.6×1.6-6L Packages
  SGM8954-2 Available in Green SOIC-8, MSOP-8 and TDFN-2×2-8L Packages

APPLICATIONS

Temperature Measurements
Medical Instrumentation
Transducer Applications
Electronic Scales
Handheld Test Equipment
Battery-Powered Instruments

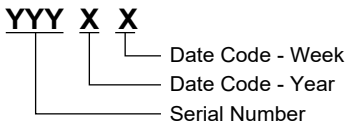
PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8954-1	SOT-23-5	-40℃ to +125℃	SGM8954-1XN5G/TR	MBBXX	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8954-1XS8G/TR	SGM 89541XS8 XXXXX	Tape and Reel, 4000
	UTDFN-1.6×1.6-6L	-40℃ to +125℃	SGM8954-1XUDN6G/TR	H6X	Tape and Reel, 3000
SGM8954-2	SOIC-8	-40℃ to +125℃	SGM8954-2XS8G/TR	SGM 89542XS8 XXXXX	Tape and Reel, 4000
	MSOP-8	-40℃ to +125℃	SGM8954-2XMS8G/TR	SGM89542 XMS8 XXXXX	Tape and Reel, 4000
	TDFN-2×2-8L	-40℃ to +125℃	SGM8954-2XTDE8G/TR	MH8 XXXX	Tape and Reel, 3000

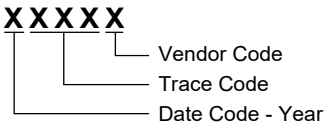
MARKING INFORMATION

NOTE: X = Date Code. XX = Date Code. XXXX = Date Code and Trace Code. XXXXX = Date Code, Trace Code and Vendor Code.

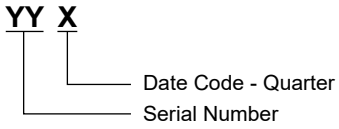
SOT-23-5



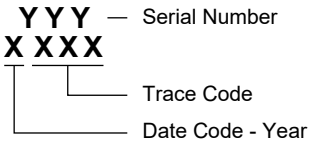
SOIC-8/MSOP-8



UTDFN-1.6×1.6-6L



TDFN-2×2-8L



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 6V
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 8000V
MM 400V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Specified 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

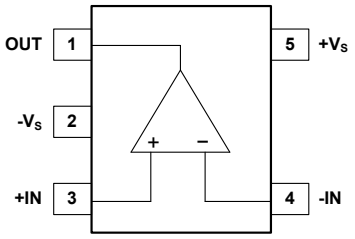
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

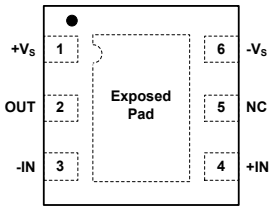
PIN CONFIGURATIONS

SGM8954-1 (TOP VIEW)



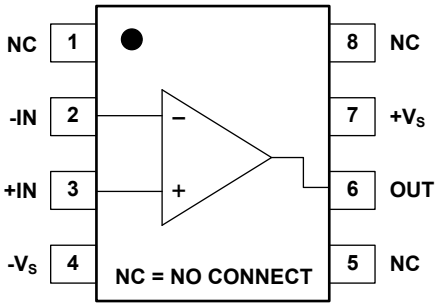
SOT-23-5

SGM8954-1 (TOP VIEW)



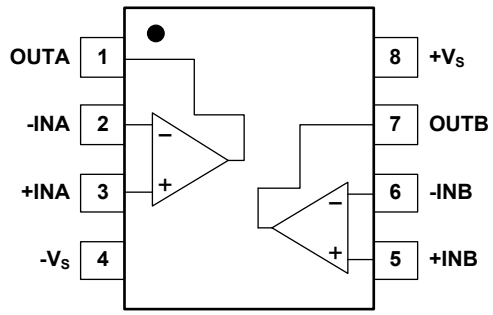
UTDFN-1.6×1.6-6L

SGM8954-1 (TOP VIEW)



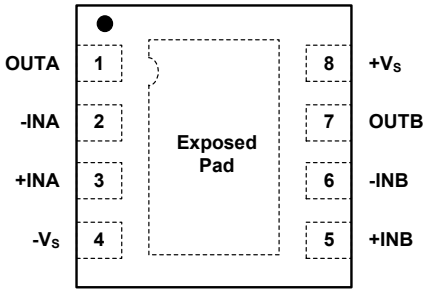
SOIC-8

SGM8954-2 (TOP VIEW)



SOIC-8/MSOP-8

SGM8954-2 (TOP VIEW)



TDFN-2×2-8L

NOTE: For UTDFN-1.6×1.6-6L and TDFN-2×2-8L packages, exposed pad can be connected to $-V_S$ or left floating.

ELECTRICAL CHARACTERISTICS

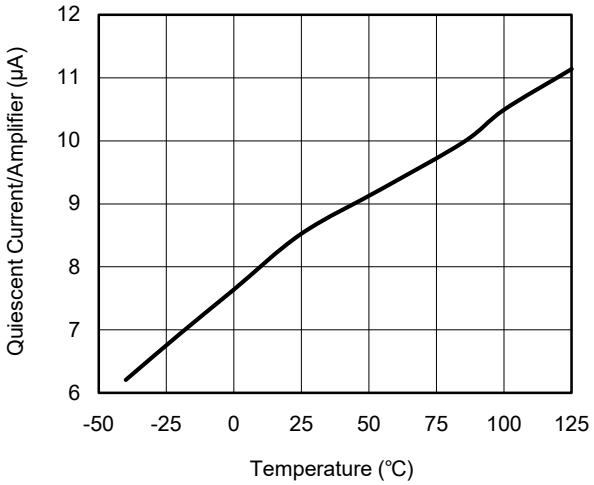
(At T_A = +25℃, V_S = 1.8V to 5.5V, V_{CM} = +V_S/2, V_{OUT} = +V_S/2 and R_L = 10kΩ to +V_S/2, Full = -40℃ to +125℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Input Characteristics							
Input Offset Voltage	V_{OS}		+25℃		8	35	μV
			Full			40	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		Full		55		nV/℃
Input Bias Current	I_B		+25℃		60	500	pA
Input Offset Current	I_{OS}		+25℃		110	700	pA
Input Common Mode Voltage Range	V_{CM}		Full	(-V_S) - 0.1		(+V_S) + 0.1	V
Common Mode Rejection Ratio	CMRR	(-V_S) - 0.1V < V_{CM} < (+V_S) + 0.1V	+25℃	93	108		dB
			Full	90			
Open-Loop Voltage Gain	A_{OL}	(-V_S) + 0.1V < V_{OUT} < (+V_S) - 0.1V, R_L = 10kΩ	+25℃	106	125		dB
			Full	103			
Output Characteristics							
Output Voltage Swing from Rail		R_L = 10kΩ	+25℃		5.5	10	mV
			Full			11	
Output Short-Circuit Current	I_{SC}	V_S = 1.8V	+25℃	5.5	8		mA
		V_S = 5.5V	+25℃	17	26		
Power Supply							
Specified Voltage Range	V_S		Full	1.8		5.5	V
Power Supply Rejection Ratio	PSRR	V_S = 1.8V to 5.5V	+25℃		1.8	10	μV/V
			Full			14	
Quiescent Current/Amplifier	I_Q	I_{OUT} = 0	+25℃		9	13	μA
			Full			15.5	
Dynamic Performance							
Gain-Bandwidth Product	GBP	C_L = 100pF	+25℃		110		kHz
Phase Margin	φ_O	C_L = 100pF	+25℃		80		°
Slew Rate	SR	G = 1	+25℃		0.04		V/μs
Overload Recovery Time		G = -10	+25℃		16		μs
Noise							
Input Voltage Noise		f = 0.1Hz to 10Hz	+25℃		1		μV_{P-P}
Input Voltage Noise Density	e_n	f = 1kHz	+25℃		65		$nV/\sqrt{Hz}$
Input Current Noise Density	i_n	f = 1kHz	+25℃		360		$fA/\sqrt{Hz}$

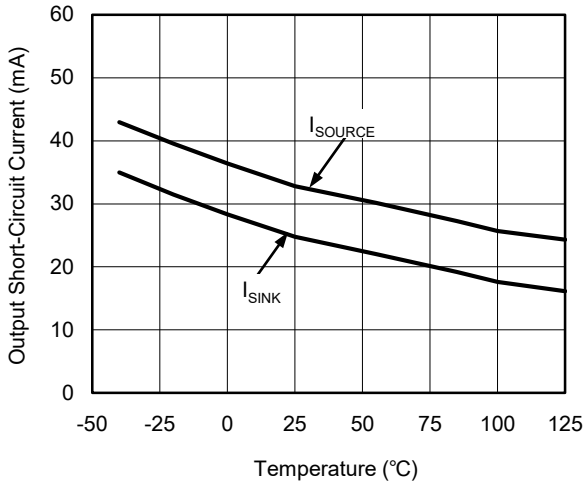
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_S = 5V, R_L = 10kΩ and C_L = 100pF, unless otherwise noted.

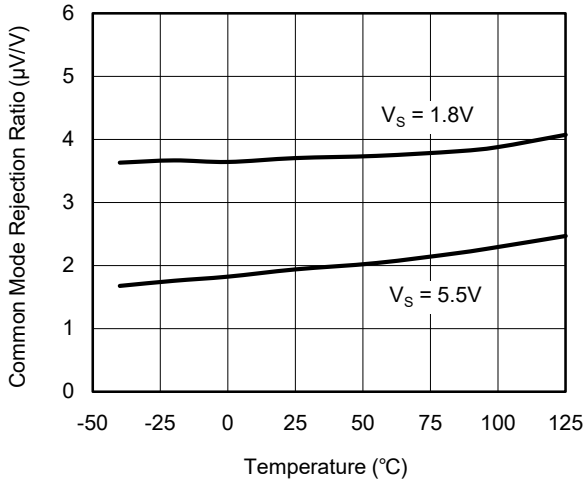
Quiescent Current vs. Temperature



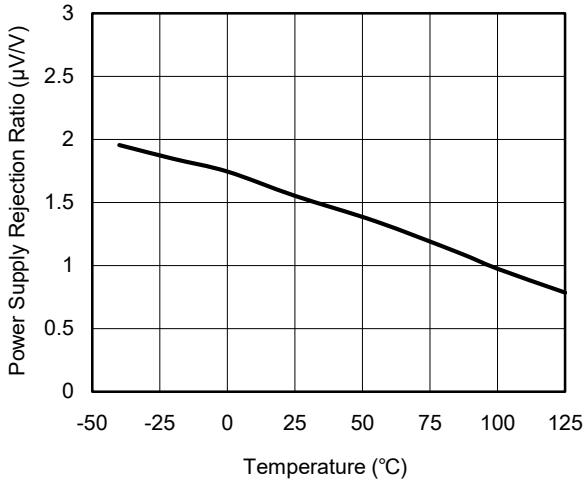
Output Short-Circuit Current vs. Temperature



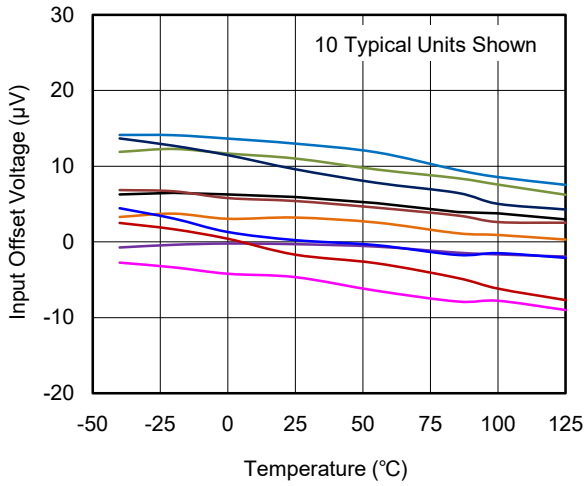
CMRR vs. Temperature



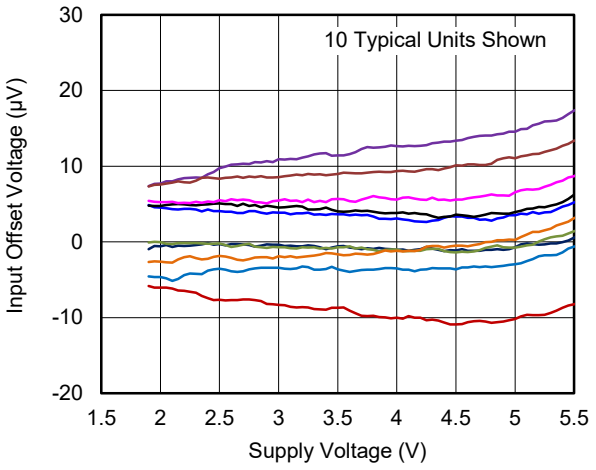
PSRR vs. Temperature



Input Offset Voltage vs. Temperature



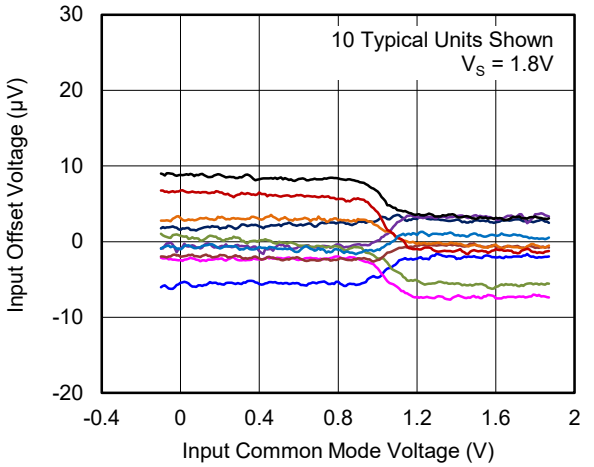
Input Offset Voltage vs. Supply Voltage



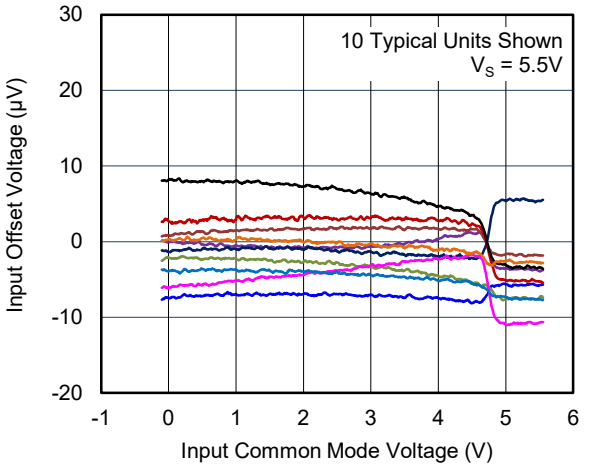
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, R_L = 10kΩ and C_L = 100pF, unless otherwise noted.

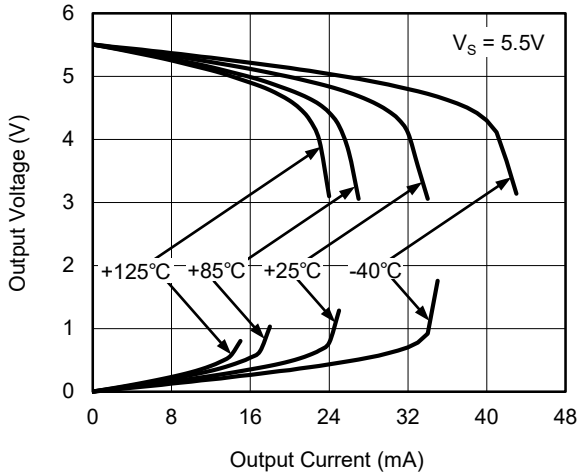
Input Offset Voltage vs. Input Common Mode Voltage



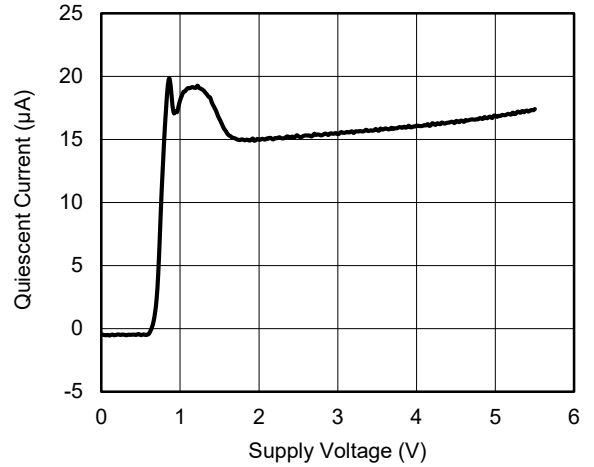
Input Offset Voltage vs. Input Common Mode Voltage



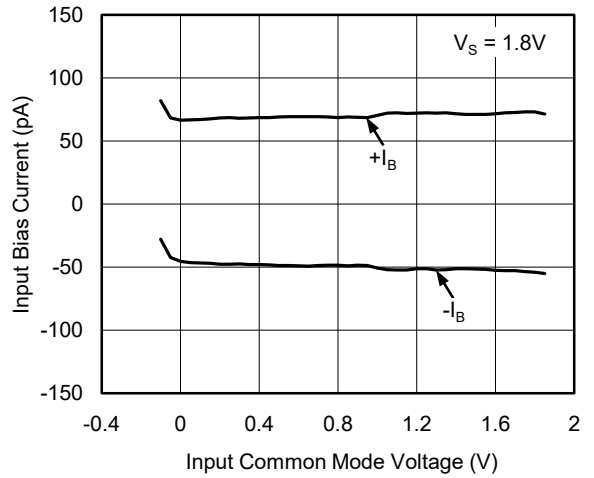
Output Voltage Swing vs. Output Current (Maximum Supply)



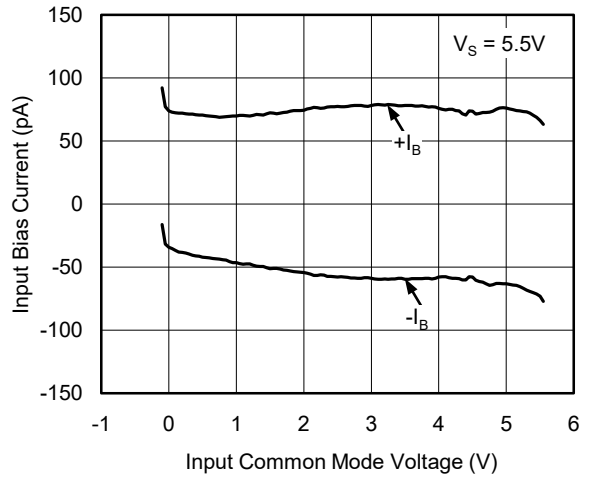
Quiescent Current vs. Supply Voltage



Input Bias Current vs. Input Common Mode Voltage



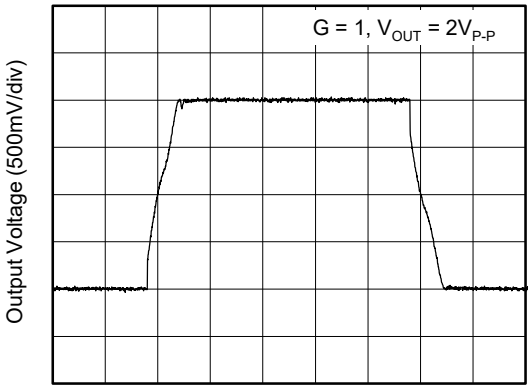
Input Bias Current vs. Input Common Mode Voltage



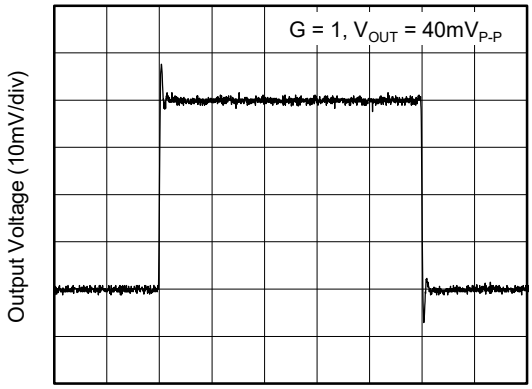
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, R_L = 10kΩ and C_L = 100pF, unless otherwise noted.

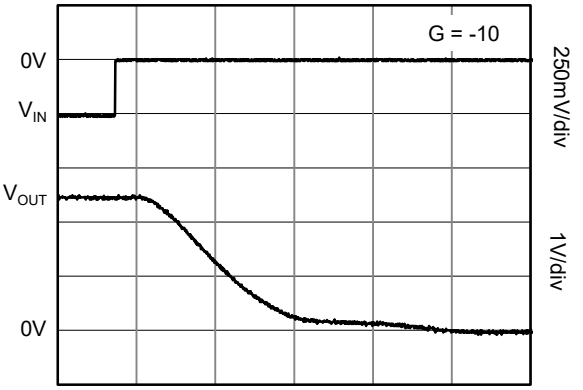
Large-Signal Step Response



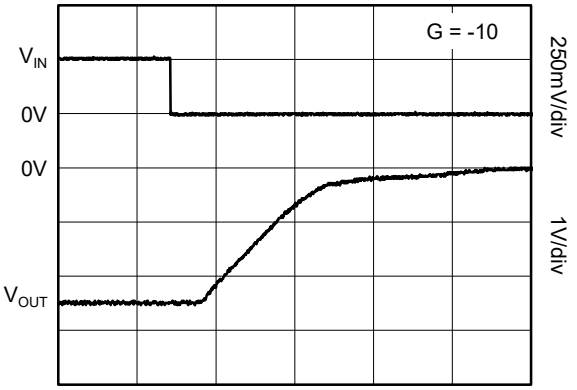
Small-Signal Step Response



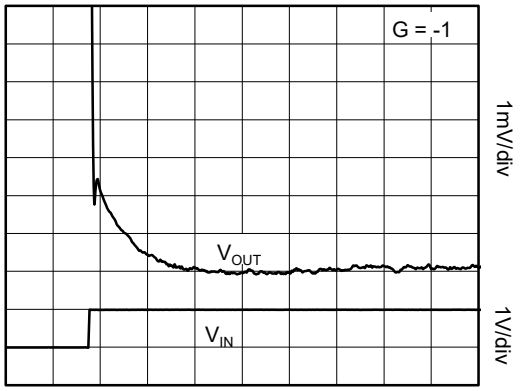
Positive Overload Recovery



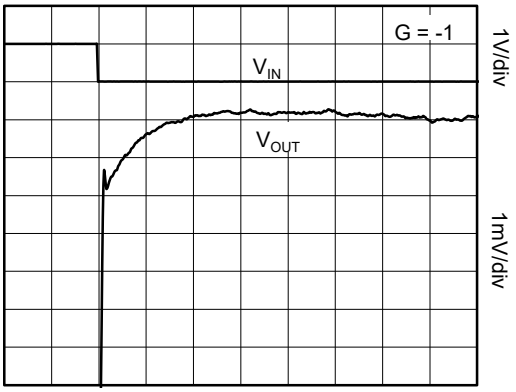
Negative Overload Recovery



Large-Signal Settling Time (Positive)



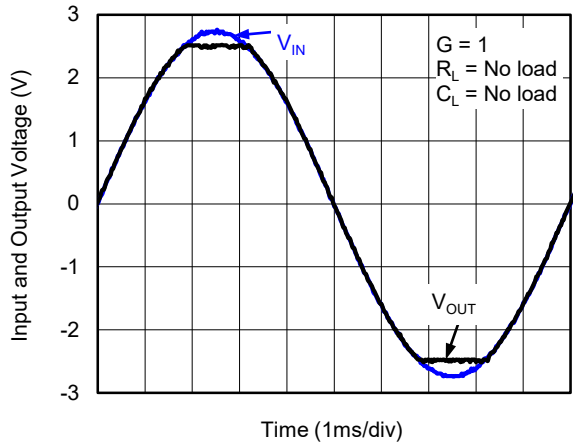
Large-Signal Settling Time (Negative)



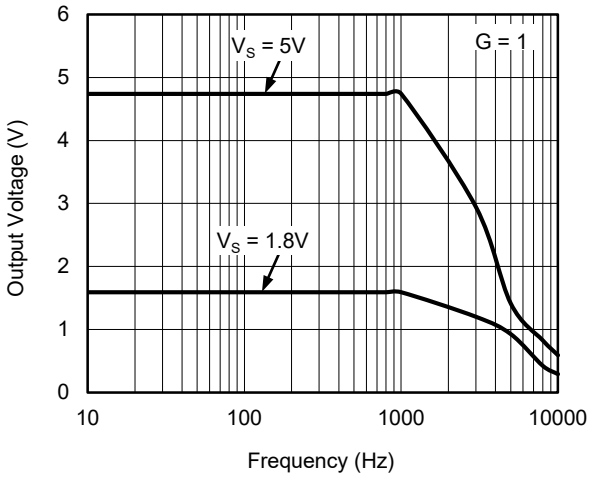
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, R_L = 10kΩ and C_L = 100pF, unless otherwise noted.

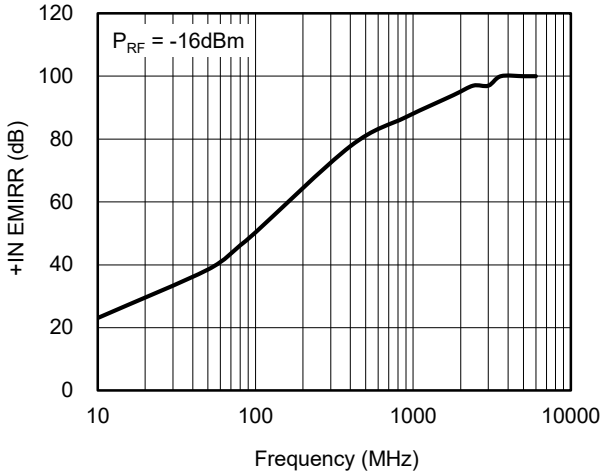
No Phase Reversal



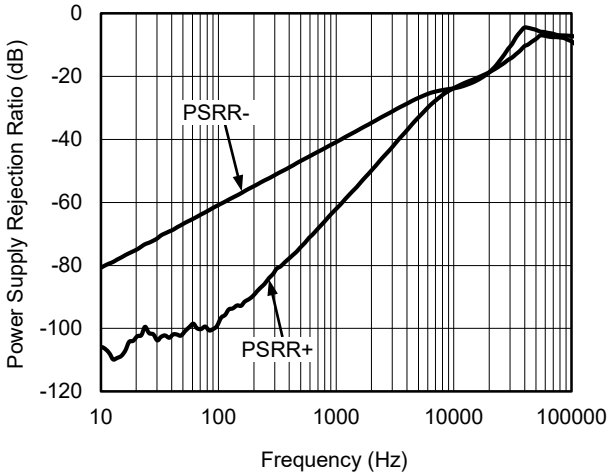
Maximum Output Voltage vs. Frequency



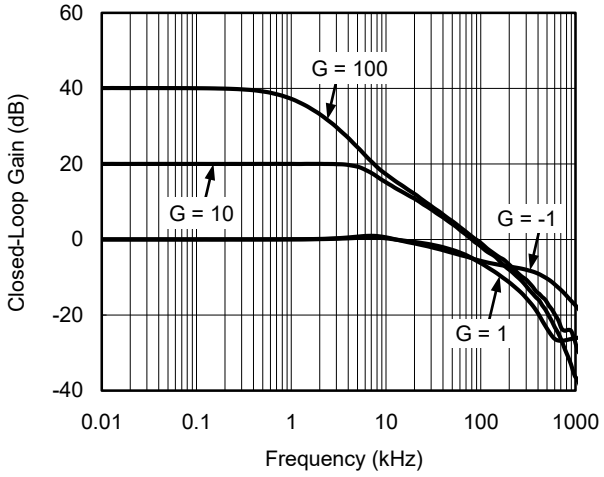
+IN EMIRR vs. Frequency



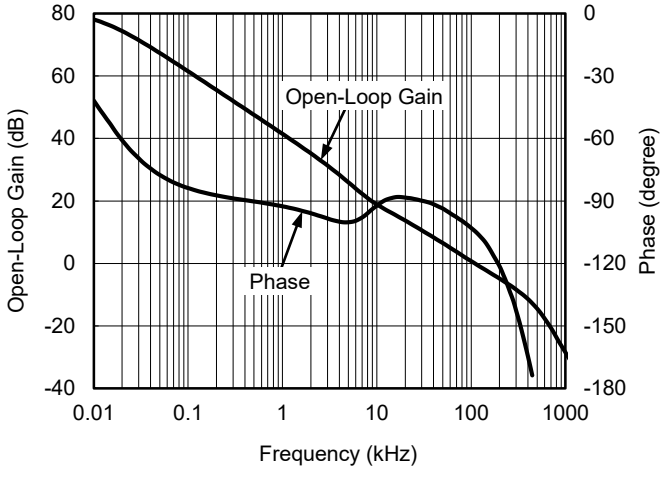
PSRR vs. Frequency (Referred-to-Input)



Closed-Loop Gain vs. Frequency



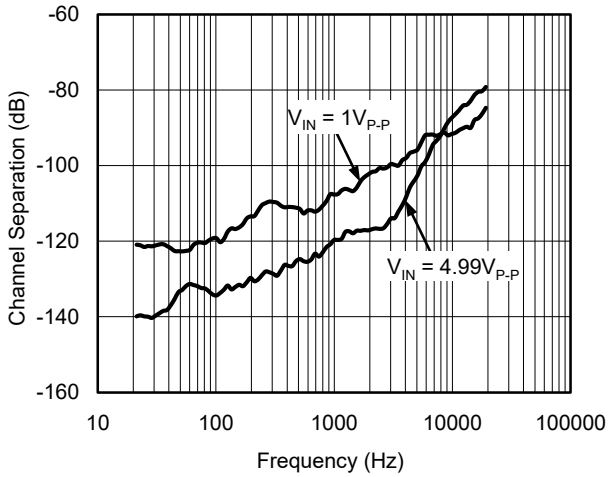
Open-Loop Gain and Phase vs. Frequency



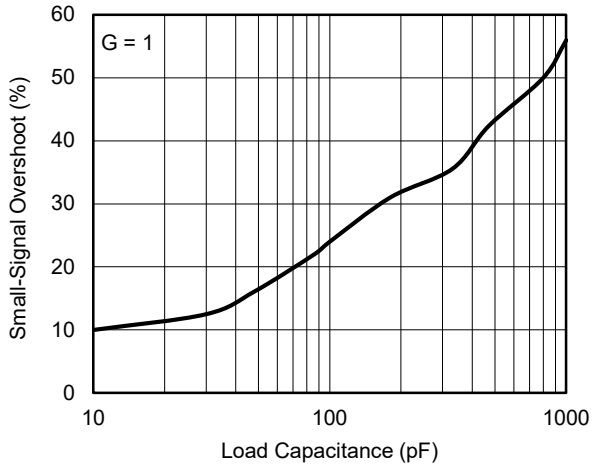
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, R_L = 10kΩ and C_L = 100pF, unless otherwise noted.

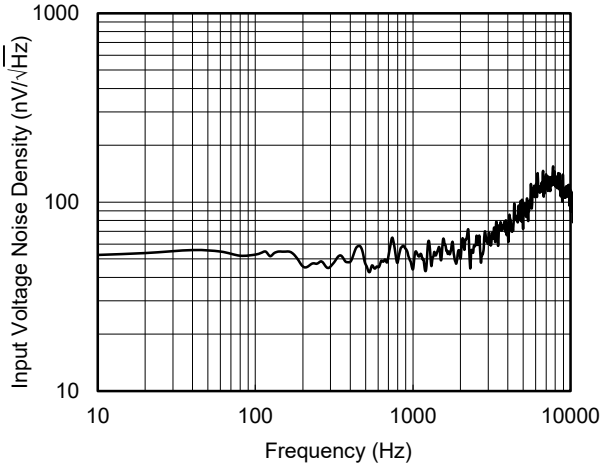
Channel Separation vs. Frequency



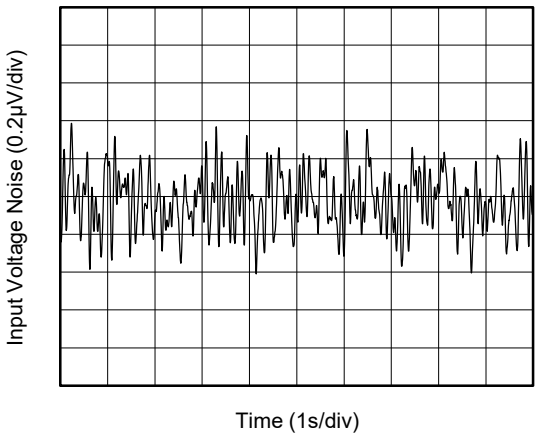
Small-Signal Overshoot vs. Capacitive Load



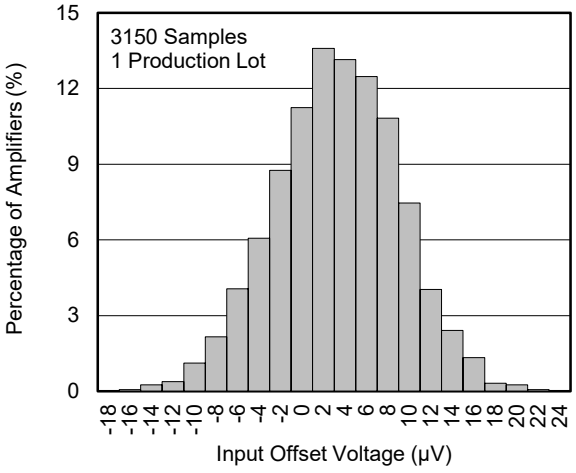
Input Voltage Noise Density vs. Frequency



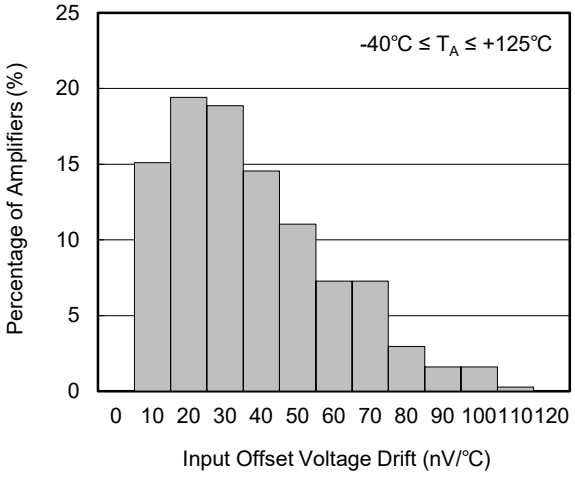
0.1Hz to 10Hz Input Voltage Noise



Input Offset Voltage Production Distribution



Input Offset Voltage Drift Distribution



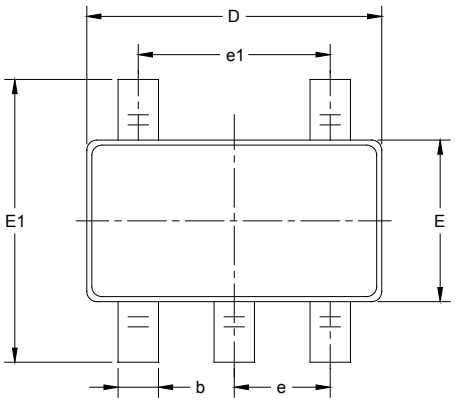
REVISION HISTORY

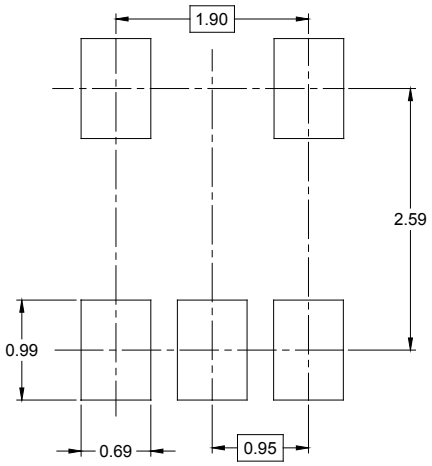
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (DECEMBER 2018) to REV.A	Page
Changed from product preview to production data	All

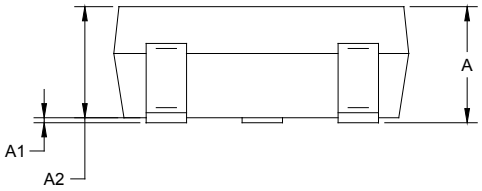
PACKAGE OUTLINE DIMENSIONS

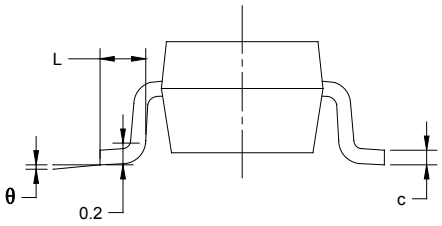
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)

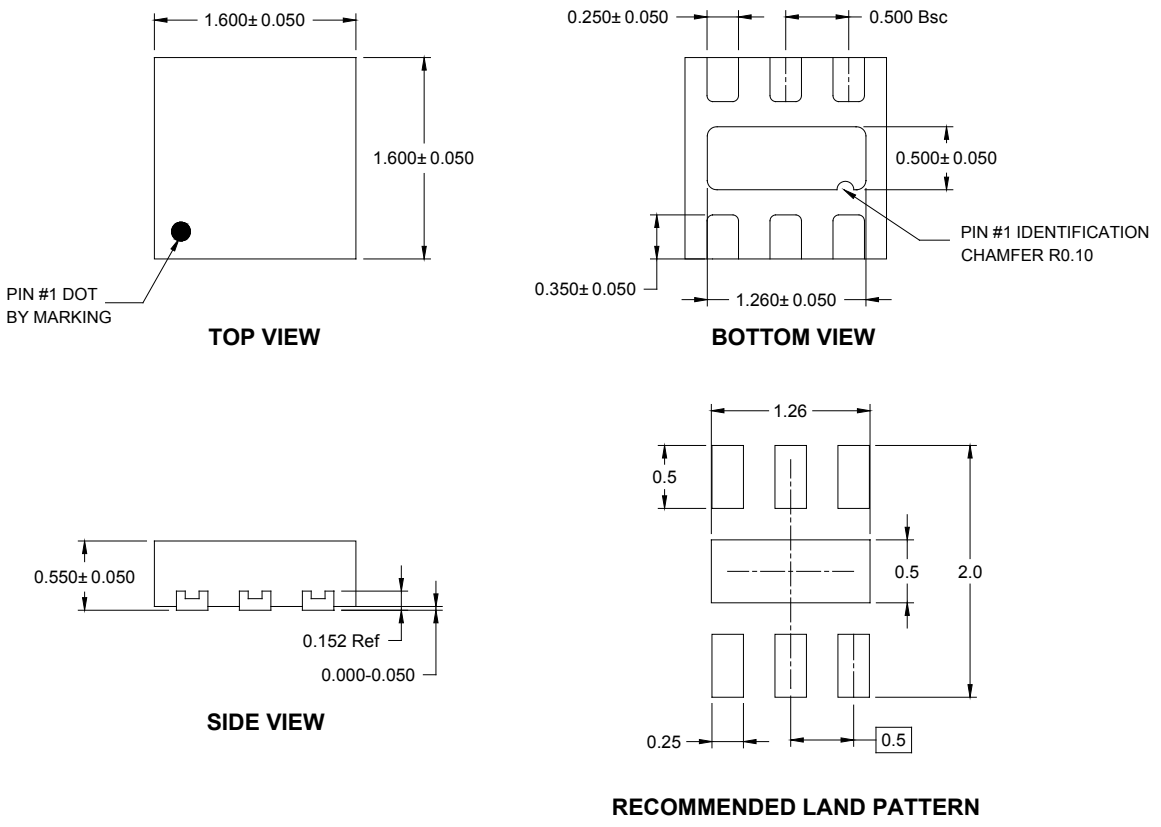




Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

PACKAGE OUTLINE DIMENSIONS

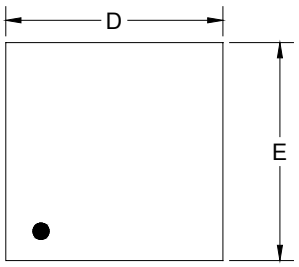
UTDFN-1.6×1.6-6L



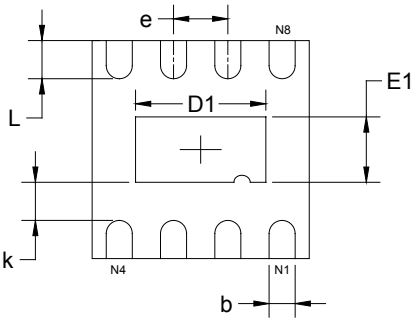
NOTE: All linear dimensions are in millimeters.

PACKAGE OUTLINE DIMENSIONS

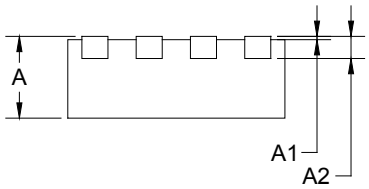
TDFN-2×2-8L



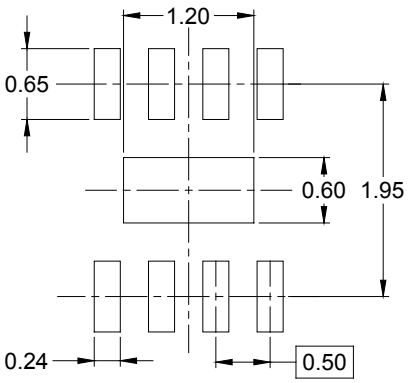
TOP VIEW



BOTTOM VIEW



SIDE VIEW

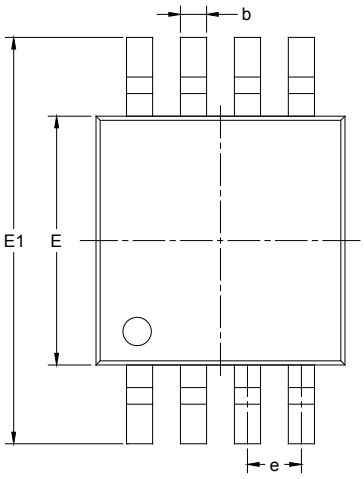


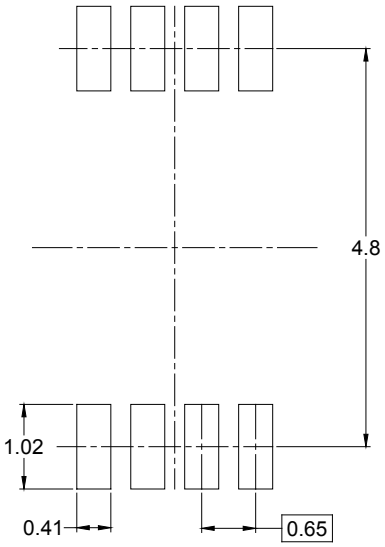
RECOMMENDED LAND PATTERN (Unit: mm)

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	1.900	2.100	0.075	0.083
D1	1.100	1.300	0.043	0.051
E	1.900	2.100	0.075	0.083
E1	0.500	0.700	0.020	0.028
k	0.200 MIN		0.008 MIN	
b	0.180	0.300	0.007	0.012
e	0.500 TYP		0.020 TYP	
L	0.250	0.450	0.010	0.018

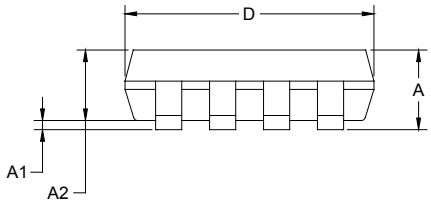
PACKAGE OUTLINE DIMENSIONS

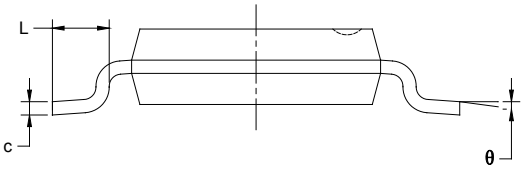
MSOP-8





RECOMMENDED LAND PATTERN (Unit: mm)

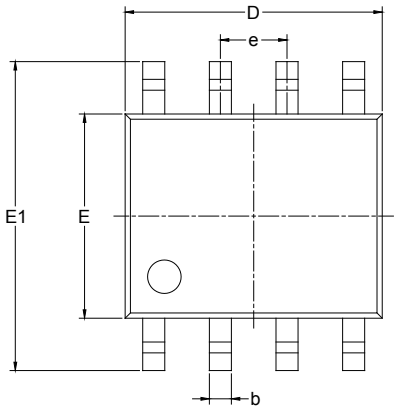


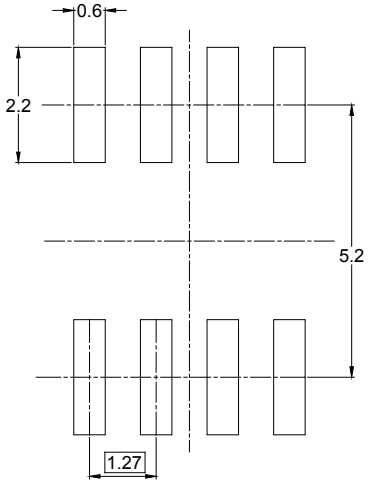


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

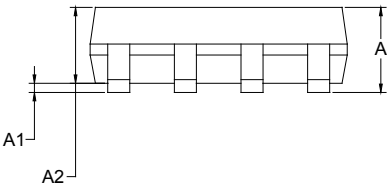
PACKAGE OUTLINE DIMENSIONS

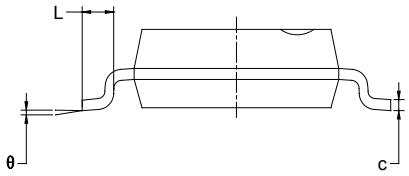
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)

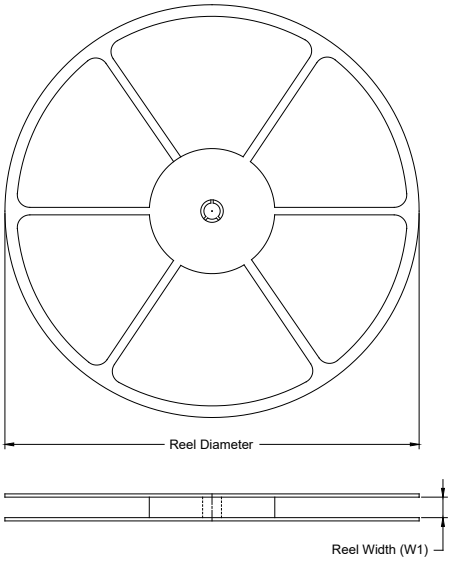




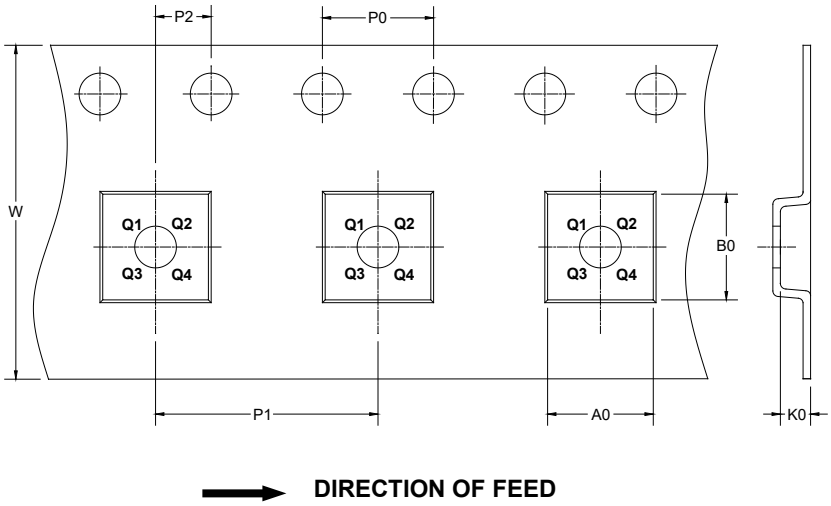
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



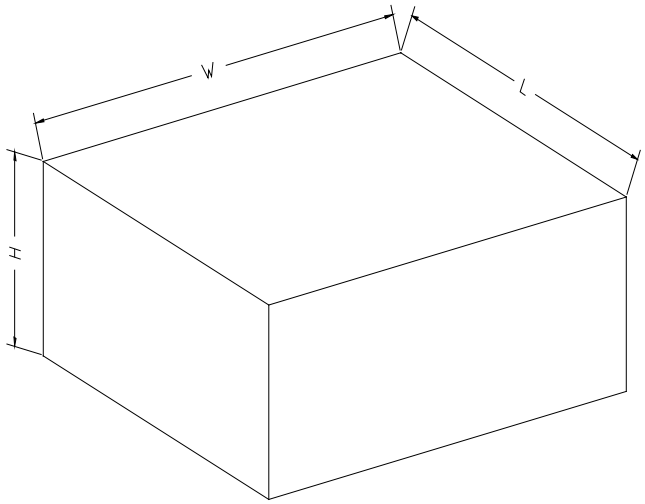
NOTE: The picture is only for reference. Please make the object as the standard.

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
UTDFN-1.6×1.6-6L	7″	9.0	1.78	1.78	0.69	4.0	4.0	2.0	8.0	Q1
TDFN-2×2-8L	7″	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q1
MSOP-8	13″	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
SOIC-8	13″	12.4	6.40	5.40	2.10	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