SGM8610-2
8.5MHz, Dual, Low Noise, Rail-to-Rail I/O Operational Amplifier

GENERAL DESCRIPTION

The SGM8610-2 is a dual, low noise operational amplifier. The device is optimized for low voltage operation from 2.5V to 5.5V single supply or ±1.25V to ±2.75V dual power supplies. It has a 1.8mA typical quiescent current. The SGM8610-2 supports rail-to-rail input and output operation.

The SGM8610-2 is unity-gain stable and offers an 8.5MHz gain-bandwidth product and 4.8V/μs slew rate. It also offers an ultra-low input bias current.

Furthermore, the SGM8610-2 features high speed and low power. It is designed for a variety of applications, such as battery-powered equipment, portable equipment, sensor interfaces and active filters.

The SGM8610-2 is available in Green UTDFN-2×2-8BL and SOIC-8 packages. It is specified over the extended -40℃ to +125℃ temperature range.

FEATURES

- **Low Noise: 34nV/$\sqrt{Hz}$ at 1kHz**
- **Low Input Offset Voltage: 1.8mV (MAX)**
- **Ultra-Low Input Bias Current: 5pA (TYP)**
- **Unity-Gain Stable**
- **Gain-Bandwidth Product: 8.5MHz**
- **High Output Current: 32mA (TYP)**
- **Rail-to-Rail Input and Output**
- **Supply Voltage Range: 2.5V to 5.5V**
- **Low Quiescent Current: 1.8mA (TYP)**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in Green UTDFN-2×2-8BL and SOIC-8 Packages**

APPLICATIONS

Battery-Powered Equipment
Portable Equipment
Active Filter
Medical Equipment
Signal Conditioning

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8610-2	UTDFN-2×2-8BL	-40℃ to +125℃	SGM8610-2XUGD8G/TR	09F XXXX	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8610-2XS8G/TR	0J5XS8 XXXXX	Tape and Reel, 4000

MARKING INFORMATION

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

UTDFN-2×2-8BL

YYY — Serial Number

XXXX

- Vendor Code
- Trace Code
- Date Code - Year

SOIC-8

XXXXX

- Vendor Code
- Trace Code
- Date Code - Year

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

Differential Input Voltage, V_{ID} .... $\pm V_S$

Input Voltage Range, V_{IN} .... $(-V_S)$ - 0.3V to $(+V_S)$ + 0.3V

Package Thermal Resistance

UTDFN-2×2-8BL, θ_{JA} .... 82℃/W

SOIC-8, θ_{JA} .... 151℃/W

Junction Temperature .... +150℃

Storage Temperature Range .... -65℃ to +150℃

Lead Temperature (Soldering, 10s) .... +260℃

ESD Susceptibility

HBM 5000V

CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Supply Voltage .... 2.5V 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

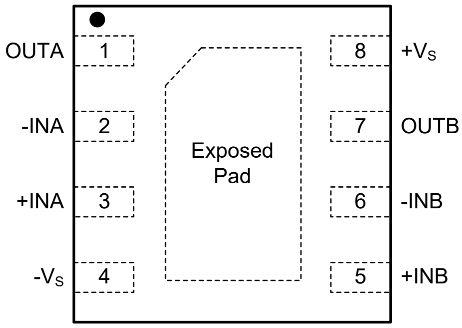
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

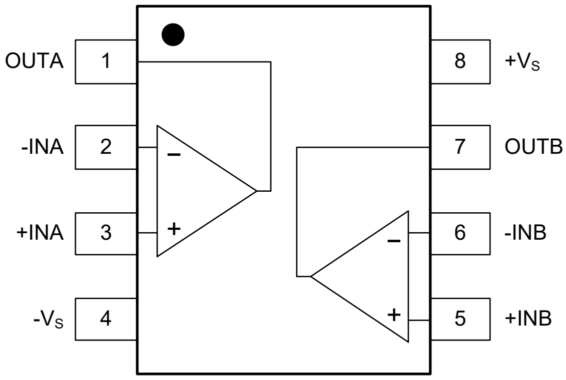
PIN CONFIGURATIONS

(TOP VIEW)



UTDFN-2×2-8BL

(TOP VIEW)



SOIC-8

ELECTRICAL CHARACTERISTICS

(For V_S = 2.5V to 5.5V, V_{CM} = V_S/2, and R_L connected to V_S/2, 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℃	-1.7		1.7	mV
			Full			1.8	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		Full		1.2		μV/℃
Input Offset Current	I_{OS}		+25℃		5	100	pA
			Full			5000	
Input Bias Current	I_B		+25℃		5	100	pA
			Full			5000	
Input Common Mode Voltage Range	V_{CM}		Full	$(-V_S)$ - 0.1		$(+V_S)$ + 0.1	V
Common Mode Rejection Ratio	CMRR	V_S = 0V to 5.5V, -0.1V < V_{CM} < $(+V_S)$ + 0.1V	+25℃	58	71		dB
			Full	55			
		V_S = 0V to 5.5V, -0.1V < V_{CM} < $(+V_S)$ - 1.4V	+25℃	70	84		
			Full	67			
Large-Signal Voltage Gain	A_V	R_L = 10kΩ, V_{OUT} = 0.5V to $(+V_S)$ - 0.5V	+25℃	90	115		dB
			Full	87			
Output Characteristics							
High-Level Output Voltage	$V_S - V_{OH}$	R_L = 10kΩ	+25℃		7	15	mV
			Full			20	
		R_L = 600Ω	+25℃		61	85	
			Full			105	
Low-Level Output Voltage	V_{OL}	R_L = 10kΩ	+25℃		5	10	mV
			Full			15	
		R_L = 600Ω	+25℃		55	80	
			Full			100	
Output Short-Circuit Current	I_{SINK}	V_{OUT} = V_S	+25℃	35	45		mA
			Full	26			
	I_{SOURCE}	V_{OUT} = 0V	+25℃	25	32		
			Full	16			

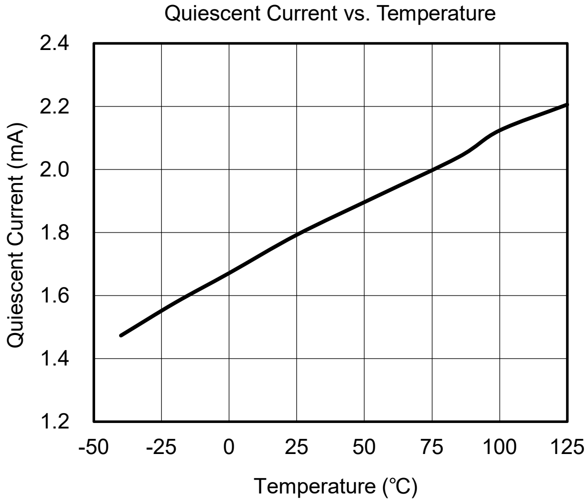
ELECTRICAL CHARACTERISTICS (continued)

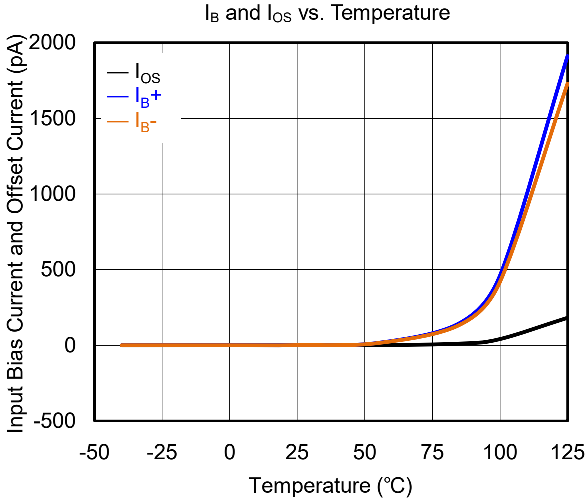
(For V_S = 2.5V to 5.5V, V_{CM} = V_S/2, and R_L connected to V_S/2, Full = -40℃ to +125℃, typical values are at T_A = +25℃, unless otherwise noted.)

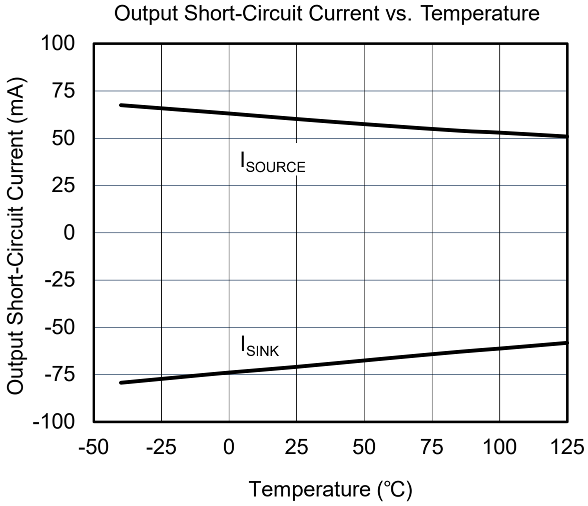
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Power Supply							
Operating Voltage Range	V_S		Full	2.5		5.5	V
Power Supply Rejection Ratio	PSRR		+25℃	85	100		dB
			Full	82			
Quiescent Current	I_Q	I_{OUT} = 0A	+25℃		1.8	2.5	mA
			Full			3	
Dynamic Performance							
Gain-Bandwidth Product	GBP	R_L = 2kΩ, C_L = 100pF	+25℃		8.5		MHz
Unity-Gain Frequency		R_L = 2kΩ, C_L = 100pF	+25℃		8.5		MHz
Phase Margin	$φ_O$	R_L = 2kΩ, C_L = 100pF	+25℃		57		°
Gain Margin	G_M	R_L = 2kΩ, C_L = 100pF	+25℃		14.5		dB
Slew Rate	SR	V_{IN} = (-V_S) + 0.5V to (+V_S) - 0.5V, G = +1, R_L = 2kΩ, C_L = 100pF	+25℃		4.8		V/μs
Total Harmonic Distortion + Noise	THD+N	G = +1, f = 1kHz, R_L = 2kΩ, BW = 22kHz, V_{OUT} = [(+V_S) - 1.6V]V_{P-P}, V_{CM} = [(+V_S) - 1.2V]/2	+25℃		0.001		%
Noise							
Input Voltage Noise Density	e_n	f = 1kHz	+25℃		34		nV/$\sqrt{Hz}$
		f = 10kHz	+25℃		12		

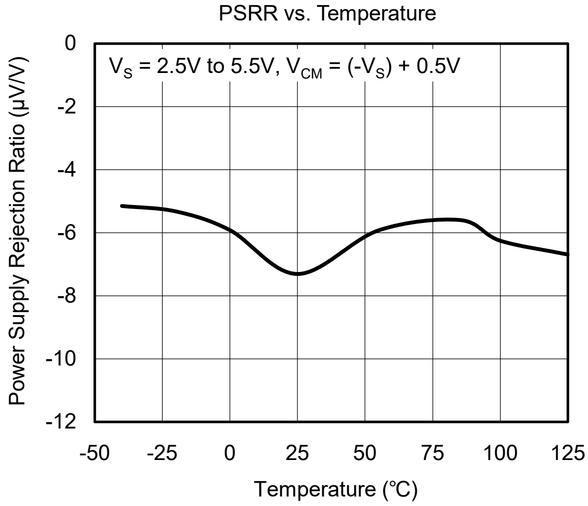
TYPICAL PERFORMANCE CHARACTERISTICS

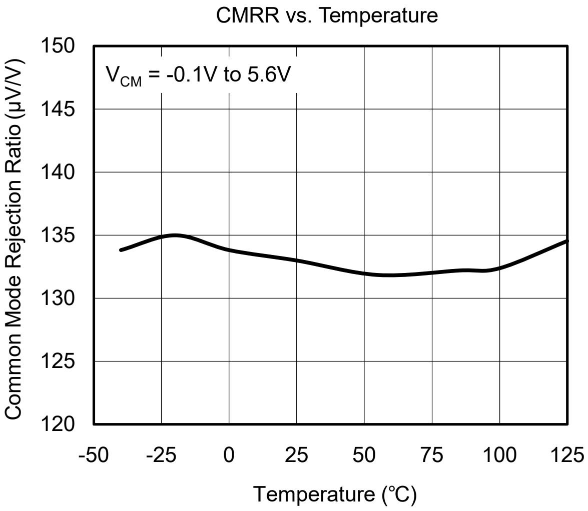
At T_A = +25℃, V_S = 5.5V, unless otherwise noted.

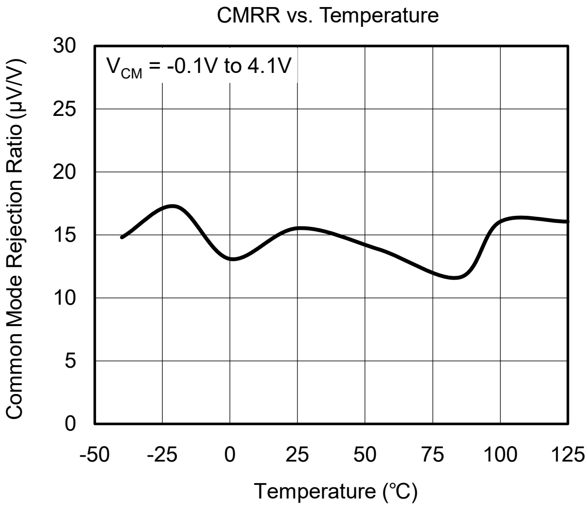








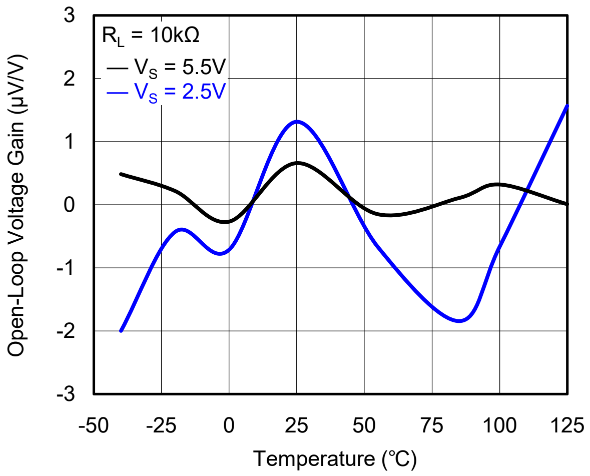




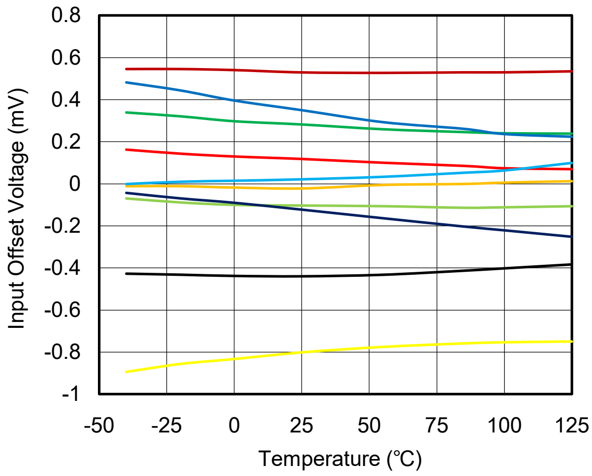
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5.5V, unless otherwise noted.

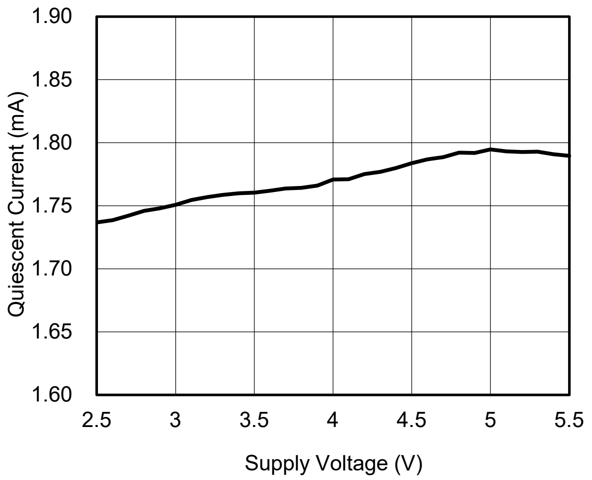
Open-Loop Voltage Gain vs. Temperature



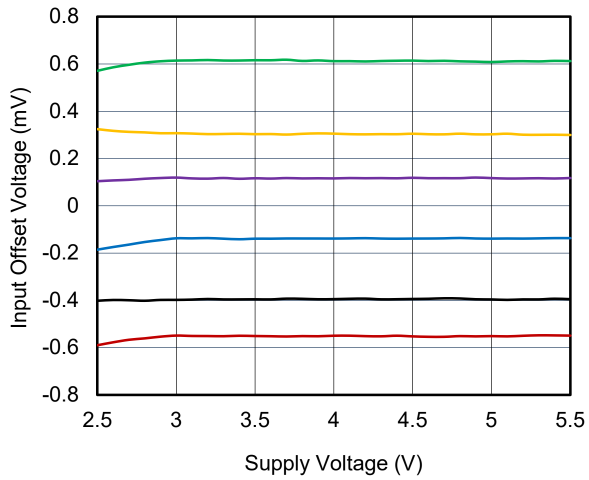
Input Offset Voltage vs. Temperature



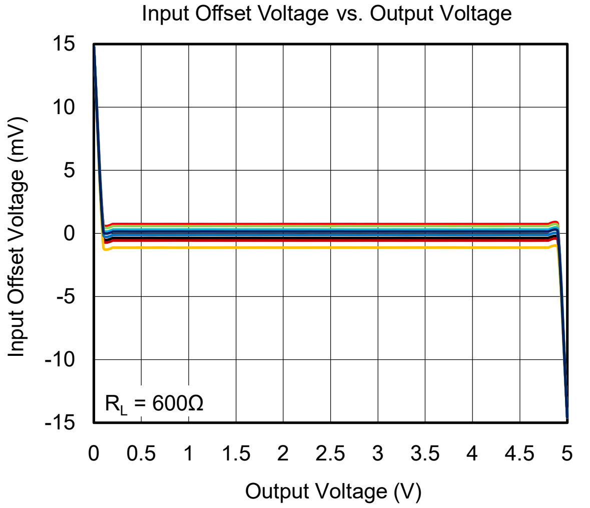
Quiescent Current vs. Supply Voltage



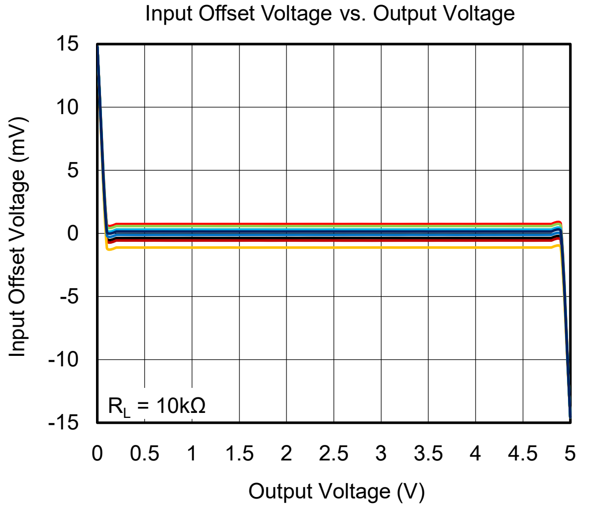
Input Offset Voltage vs. Supply Voltage



Input Offset Voltage vs. Output Voltage

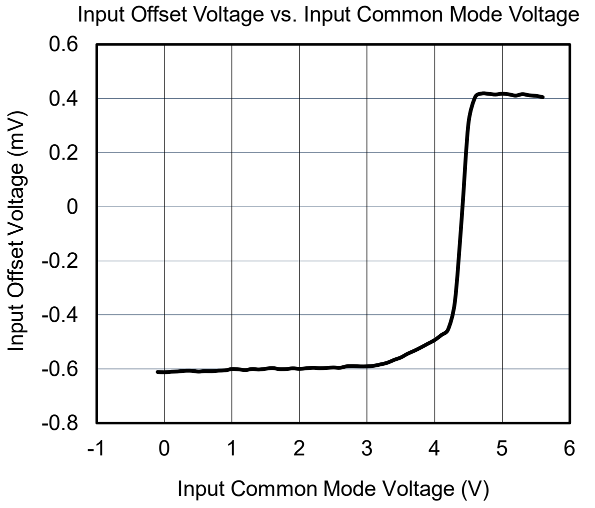


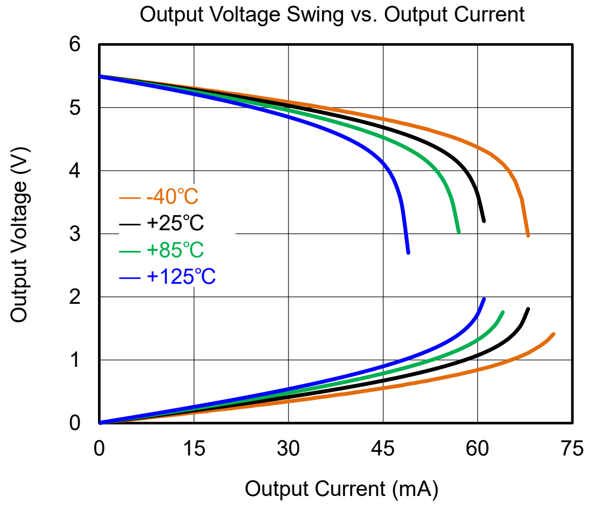
Input Offset Voltage vs. Output Voltage

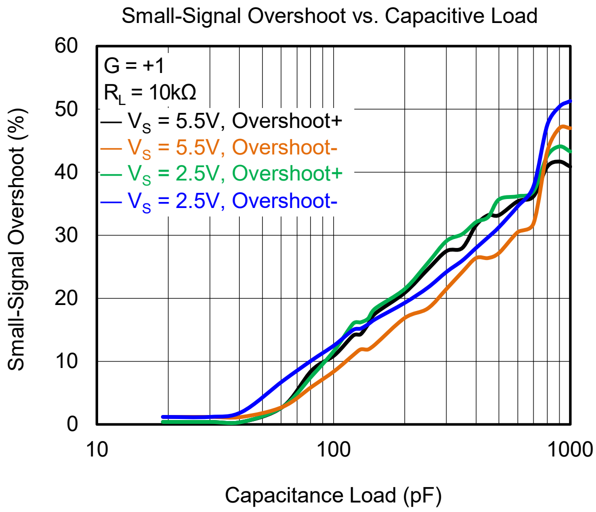


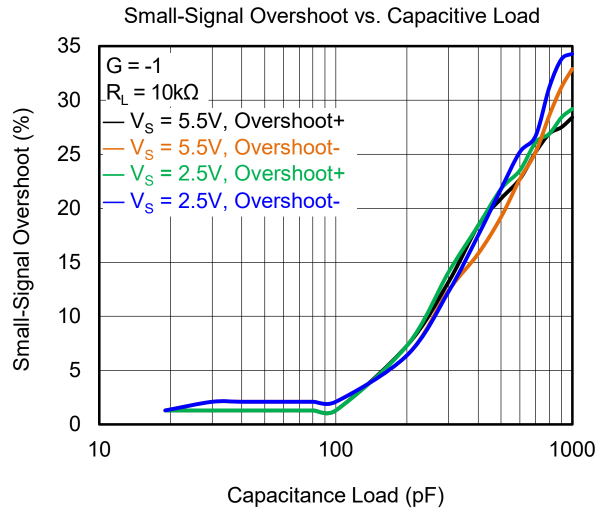
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

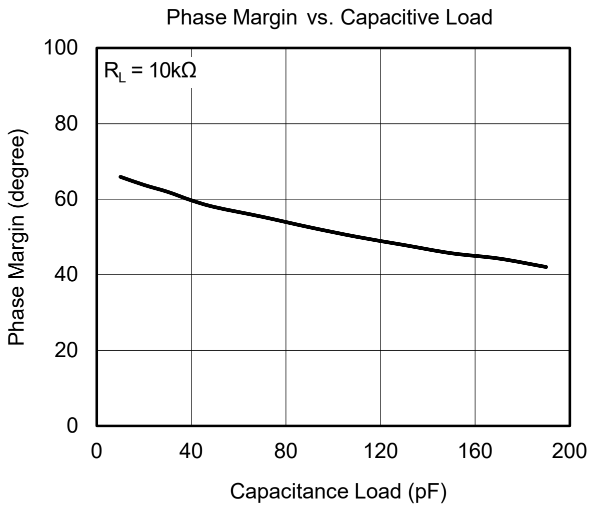
At T_A = +25℃, V_S = 5.5V, unless otherwise noted.

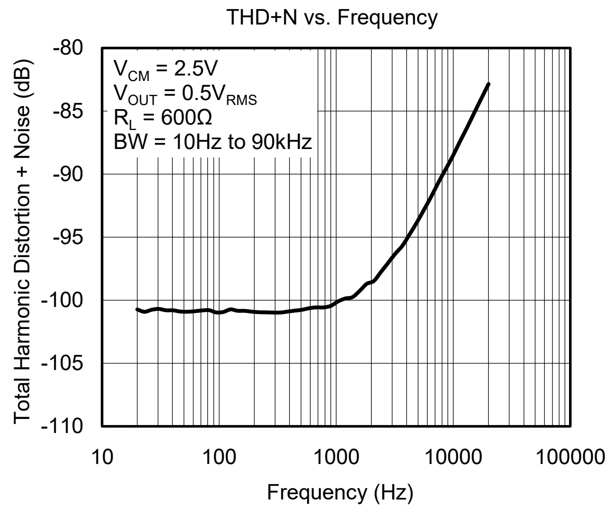






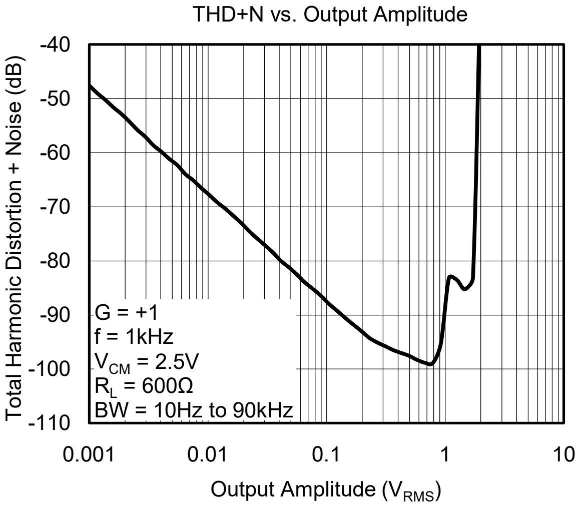


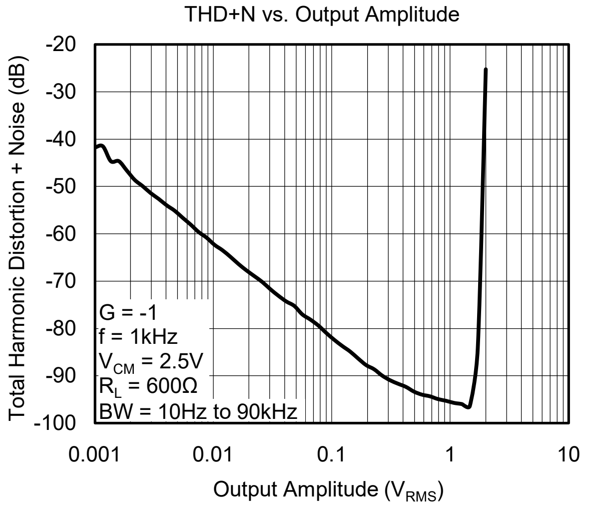


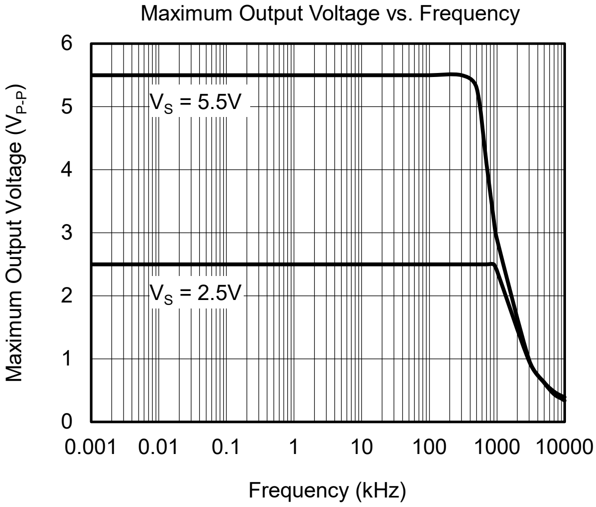


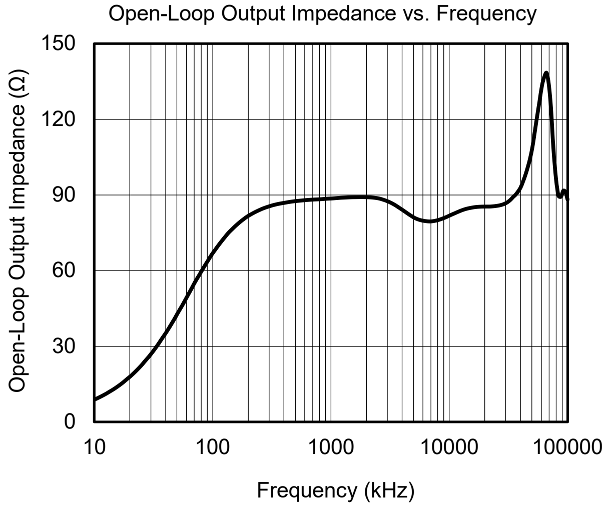
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

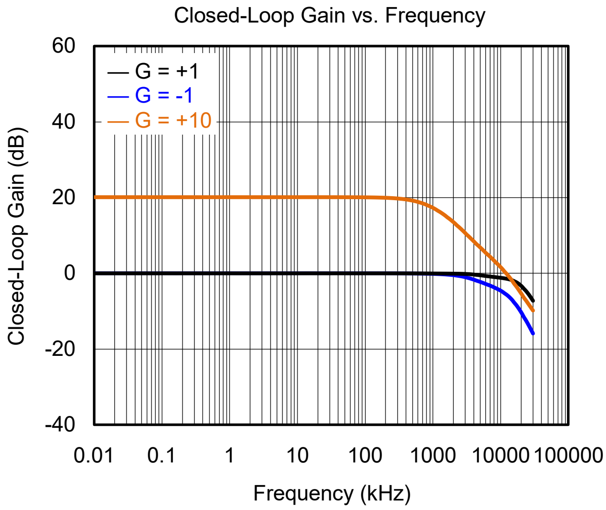
At T_A = +25℃, V_S = 5.5V, unless otherwise noted.

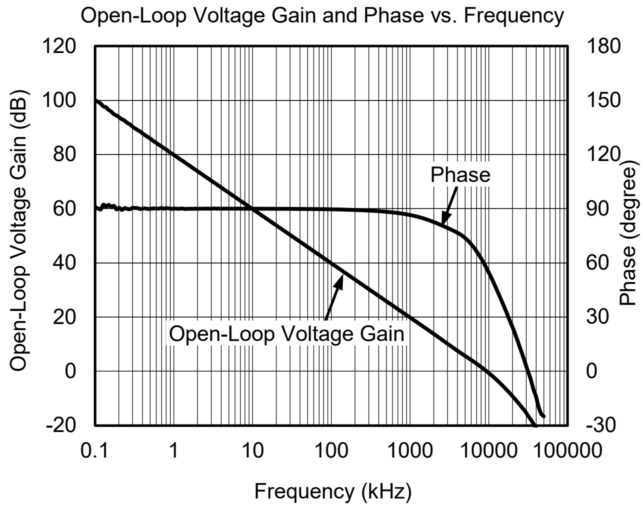






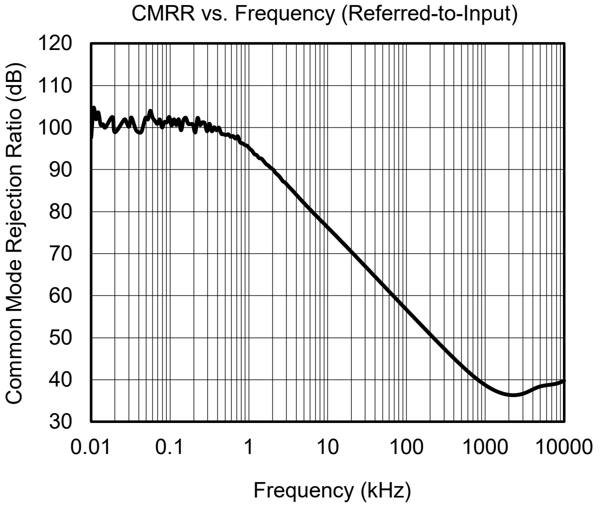


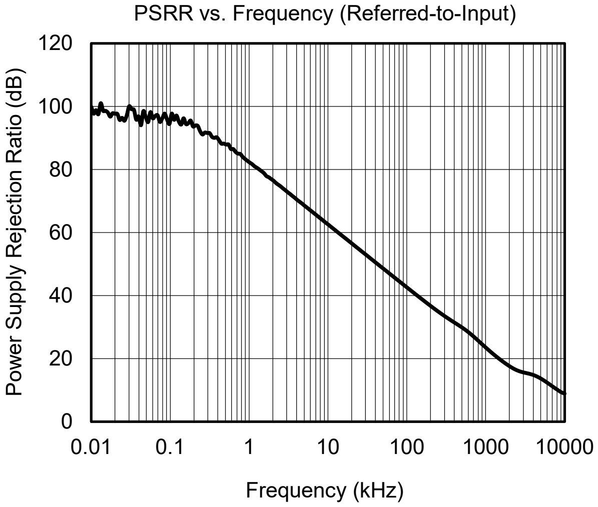


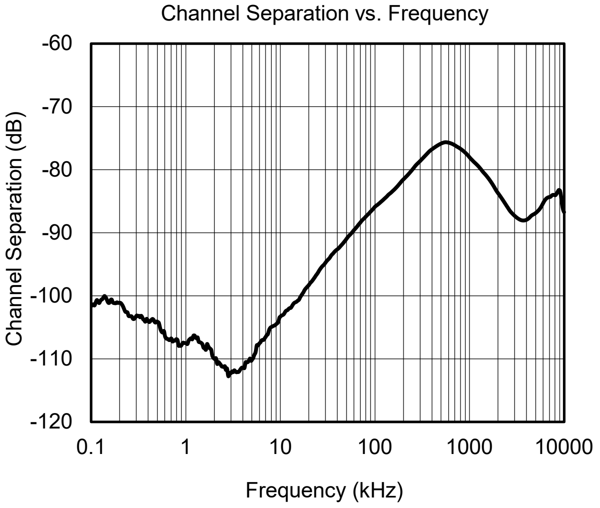


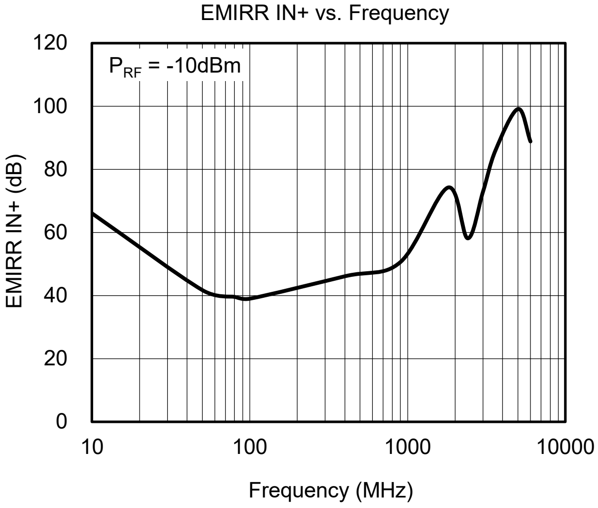
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

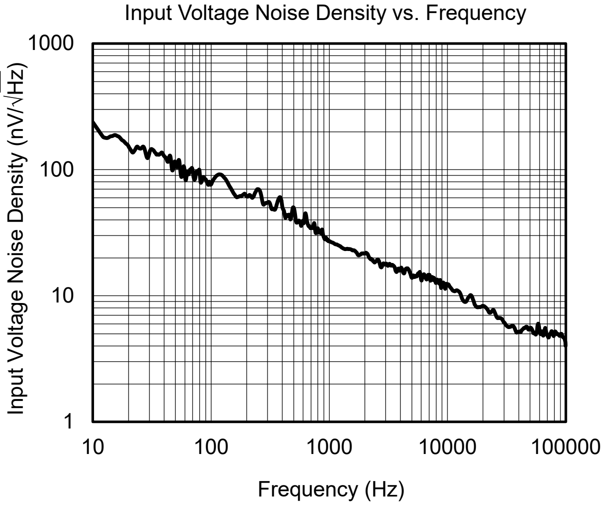
At T_A = +25℃, V_S = 5.5V, unless otherwise noted.

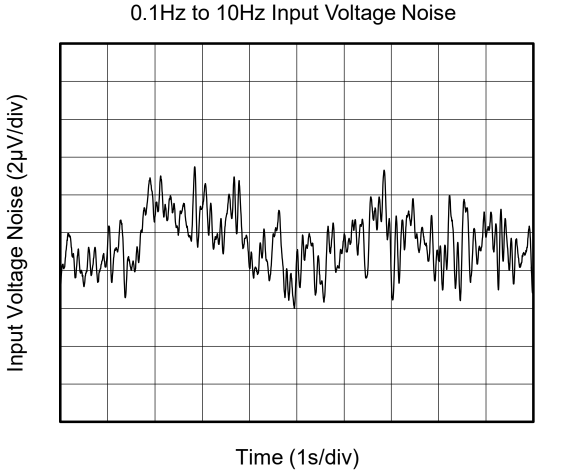










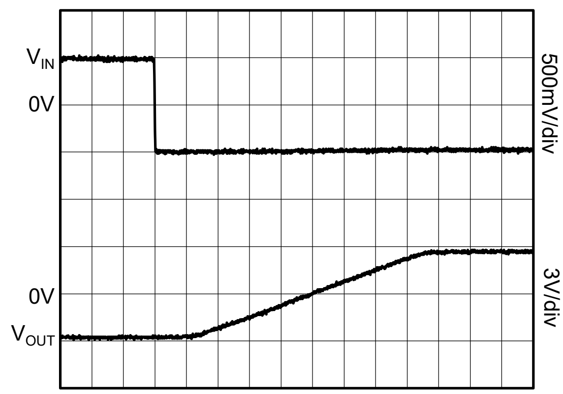


TYPICAL PERFORMANCE CHARACTERISTICS (continued)

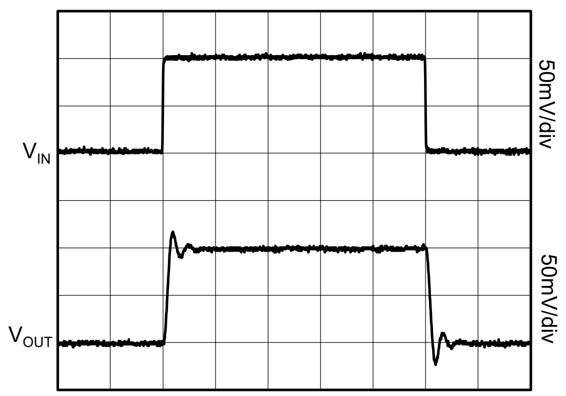
At T_A = +25℃, V_S = 5.5V, unless otherwise noted.

Positive Overload Recovery

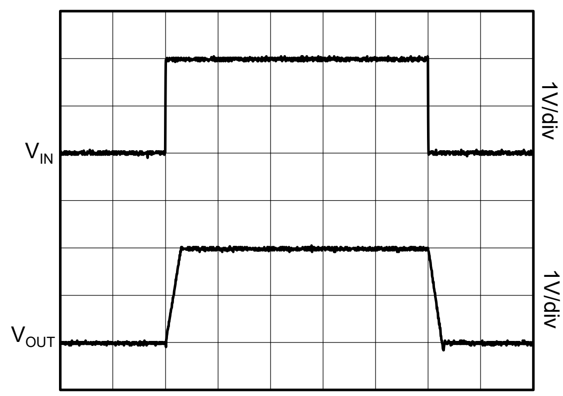
Negative Overload Recovery



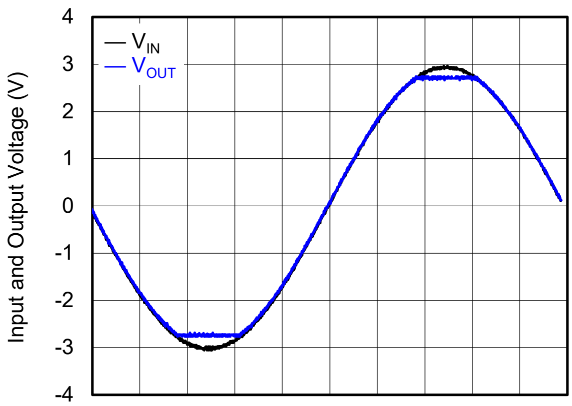
Small-Signal Step Response



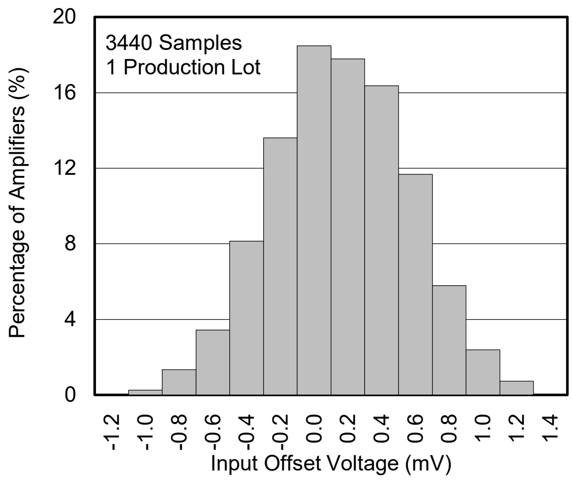
Large-Signal Step Response



No Phase Reversal

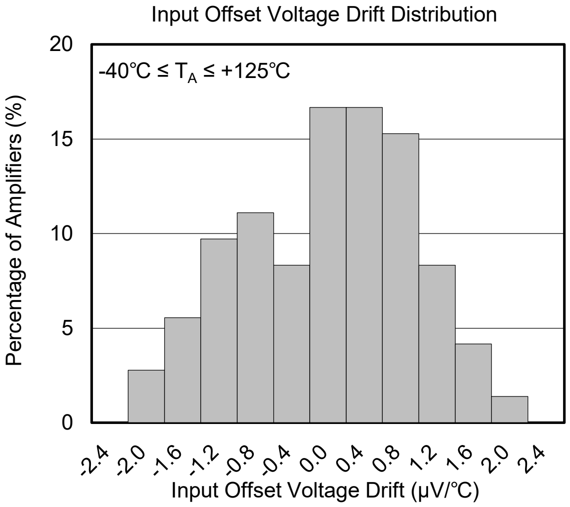


Input Offset Voltage Production Distribution



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5.5V, unless otherwise noted.



APPLICATION INFORMATION

Rail-to-Rail Input

When SGM8610-2 works at the power supply between 2.5V and 5.5V, the input common mode voltage range is from ($-V_S$) - 0.1V to ($+V_S$) + 0.1V. In Figure 1, the ESD diodes between the inputs and the power supply rails will clamp the input voltage not to exceed the rails.

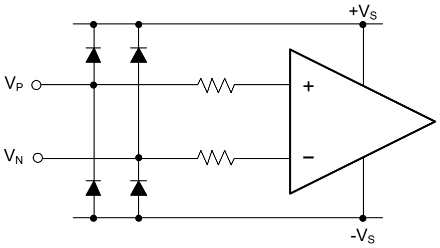


Figure 1. Input Equivalent Circuit

Input Current-Limit Protection

For ESD diode clamping protection, when the current flowing through ESD diode exceeds the maximum rating value, the ESD diode and amplifier will be damaged, so current-limit protection will be added in some applications. One resistor is selected to limit the current not to exceed the maximum rating value. In Figure 2, a series input resistor is used to limit the input current to less than 10mA, but the drawback of this current-limit resistor is that it contributes thermal noise at the amplifier input. If this resistor must be added, its value must be selected as small as possible.

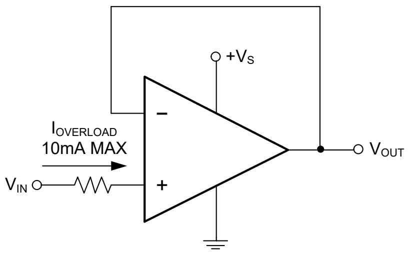


Figure 2. Input Current-Limit Protection

Rail-to-Rail Output

The SGM8610-2 supports rail-to-rail output operation. In single power supply application, for example, when $+V_S$ = 5.5V, $-V_S$ = GND, 10kΩ load resistor is tied from OUT pin to $V_S/2$, the typical output swing range is from 0.007V to 5.493V.

Driving Capacitive Loads

The SGM8610-2 is designed for driving the 1000pF capacitive load with unity-gain stable. If greater capacitive load must be driven in application, the circuit in Figure 3 can be used. In this circuit, the IR drop voltage generated by R_{ISO} is compensated by feedback loop.

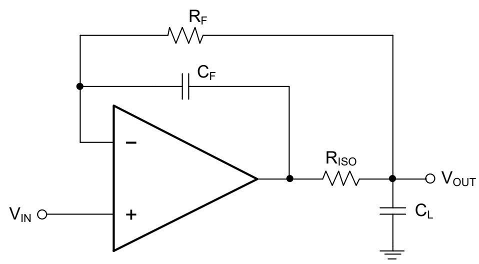


Figure 3. Circuit to Drive Heavy Capacitive Load

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 4. The ceramic capacitors should be placed as close as possible to $+V_S$ and $-V_S$ power supply pins.

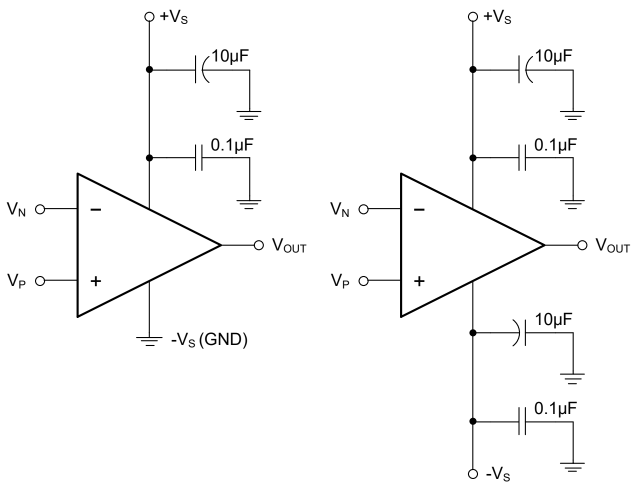


Figure 4. Amplifier Power Supply Bypassing

APPLICATION INFORMATION (continued)

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

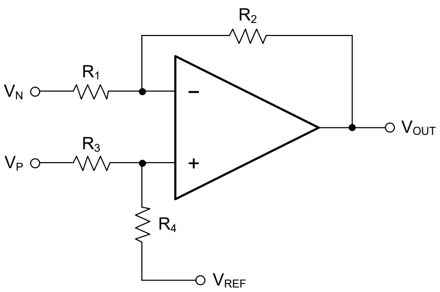


Figure 5. Difference Amplifier

High Input Impedance Difference Amplifier

The circuit in Figure 6 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 5.

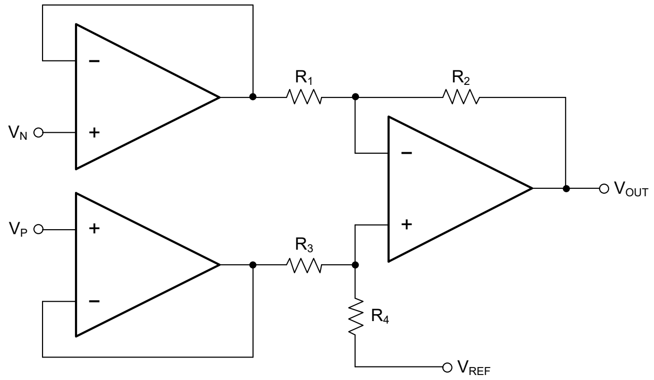


Figure 6. High Input Impedance Difference Amplifier

Active Low-Pass Filter

The circuit in Figure 7 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 $1/2\pi R_2C$. In this design, the filter bandwidth must be less than the bandwidth of the amplifier, and the resistor values must be selected as low as possible to reduce ringing or oscillation generated by the parasitic parameters in PCB layout.

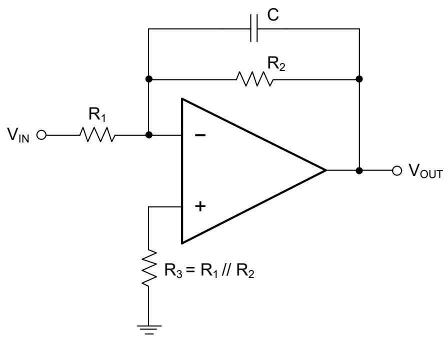


Figure 7. Active Low-Pass Filter

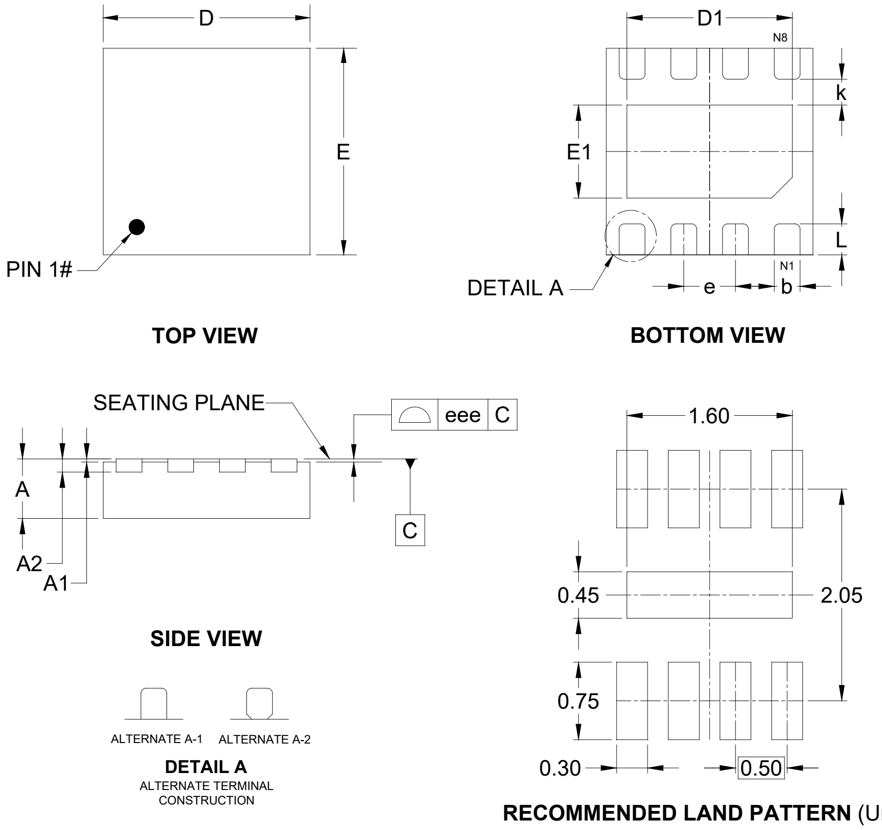
REVISION HISTORY

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

Changes from Original (NOVEMBER 2023) to REV.A	**Page**
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

UTDFN-2×2-8BL



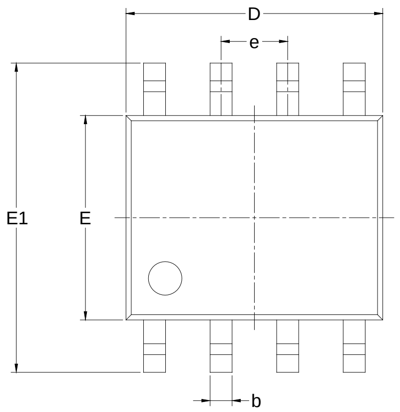
RECOMMENDED LAND PATTERN (Unit: mm)

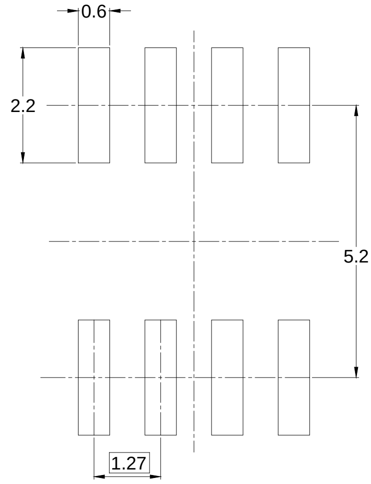
Symbol	Dimensions In Millimeters		
	MIN	**MOD**	**MAX**
A	0.500	-	0.600
A1	0.000	-	0.050
A2	0.127 REF		
b	0.200	-	0.300
D	1.900	-	2.100
E	1.900	-	2.100
D1	1.500	1.600	1.700
E1	0.800	0.900	1.000
e	0.500 BSC		
k	0.250 REF		
L	0.200	-	0.400
eee	0.050		

NOTE: This drawing is subject to change without notice.

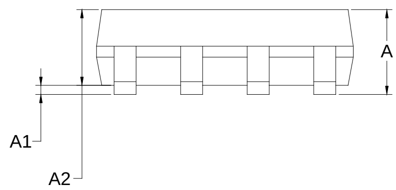
PACKAGE OUTLINE DIMENSIONS

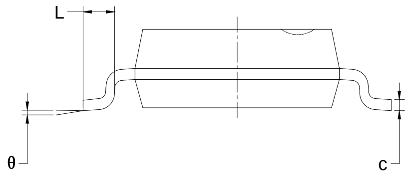
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)



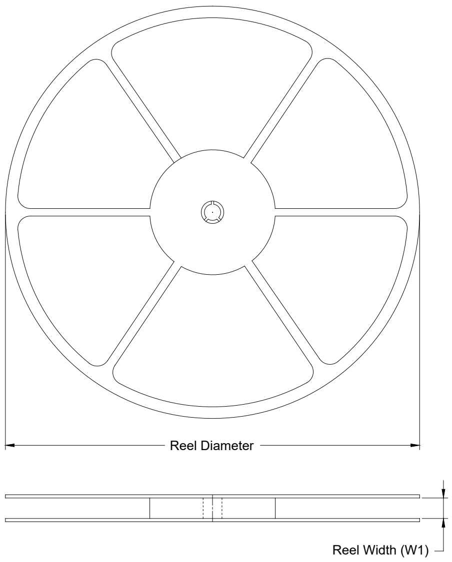


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

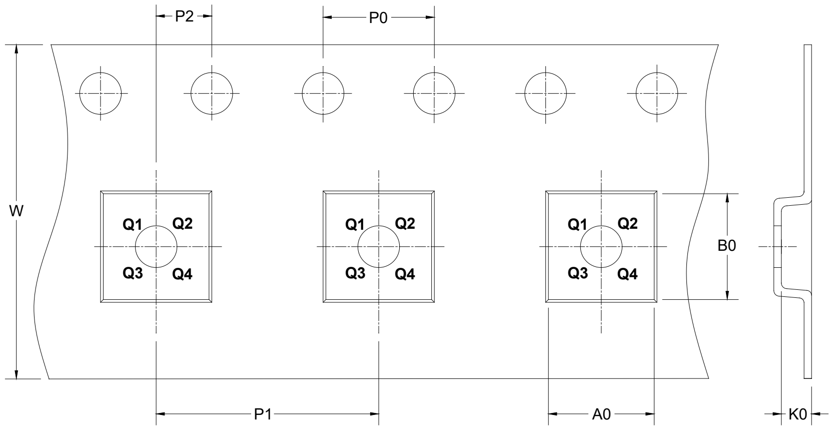
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

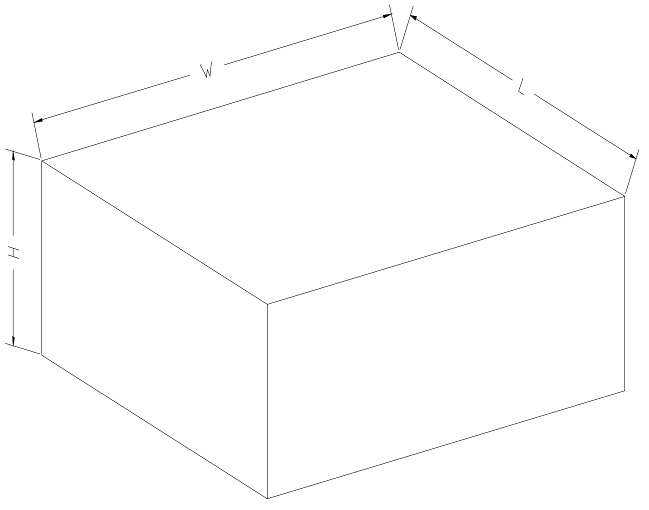
NOTE: The picture is only for reference. Please make the object as the standard.

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
UTDFN-2×2-8BL	7″	9.5	2.25	2.25	0.75	4.0	4.0	2.0	8.0	Q2
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