



SGM8600

2.2mA, 11MHz, Low Noise, Rail-to-Rail I/O Tiny Package, CMOS Operational Amplifier

GENERAL DESCRIPTION

The SGM8600 is a dual, low noise, low voltage and low power operational amplifier that can be designed into a wide range of applications. The SGM8600 has a high gain-bandwidth product of 11MHz, a slew rate of 8.5V/ μ s, and a quiescent current of 2.2mA at 5V.

The SGM8600 is designed to provide optimal performance in low voltage and low noise systems. It provides rail-to-rail output swing into heavy loads. The input common mode voltage range includes ground, and the maximum input offset voltage is 4mV for SGM8600. The operating supply range is from 2.1V to 5.5V.

The dual SGM8600 is available in Green SOIC-8 and TDFN-2 \times 2-8L packages. It is specified over the extended industrial temperature range (-40°C to +125°C).

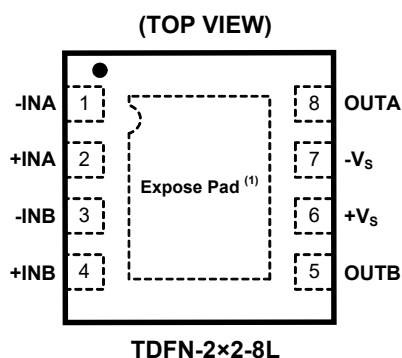
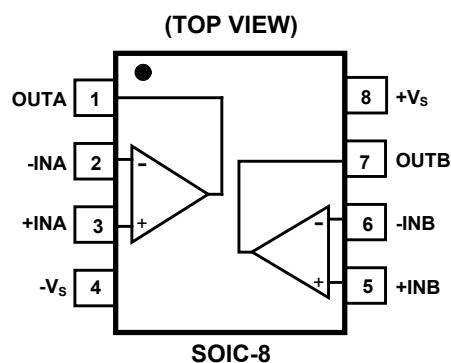
APPLICATIONS

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

FEATURES

- Rail-to-Rail Input and Output
- Offset Voltage Range is from 0mV to 4mV
- High Gain-Bandwidth Product: 11MHz
- High Slew Rate: 8.5V/ μ s
- Settling Time to 0.1% with 2V Step: 0.21 μ s
- Overload Recovery Time: 0.6 μ s
- Low Noise: 8.5nV/ $\sqrt{\text{Hz}}$ at 10kHz
- Supply Voltage Range: 2.1V to 5.5V
- Input Common Mode Voltage Range:
-0.1V to 5.6V with $V_S = 5.5\text{V}$
- Low Power:
2.2mA Typical Supply Current
- -40°C to +125°C Operating Temperature Range
- Available in Green SOIC-8 and TDFN-2 \times 2-8L Packages

PIN CONFIGURATIONS



NOTE 1: Exposed pad can be connected to - V_S or left floating.

2.2mA, 11MHz, Low Noise, Rail-to-Rail I/O Tiny Package, CMOS Operational Amplifier

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8600	SOIC-8	-40°C to +125°C	SGM8600XS8G/TR	SGM 8600XS8 XXXXX	Tape and Reel, 2500
	TDFN-2×2-8L	-40°C to +125°C	SGM8600XTDE8G/TR	8600 XXXX	Tape and Reel, 3000

XXXXX

Vendor Code

Date Code - Week

Date Code - Year

ELECTRICAL CHARACTERISTICS

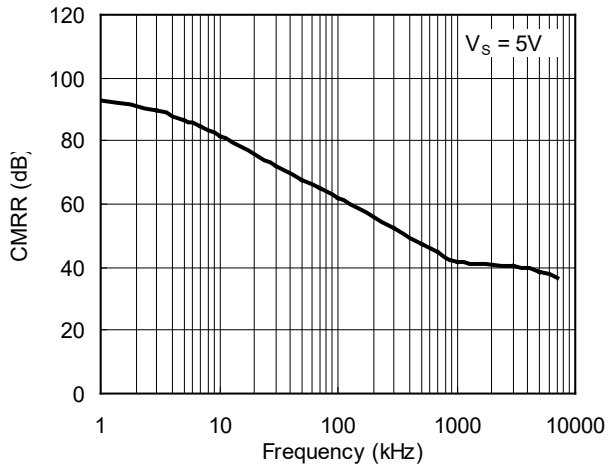
(At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, $V_{CM} = V_S/2$, $R_L = 600\Omega$, unless otherwise noted.)

PARAMETER	CONDITIONS	SGM8600					
		TYP	MIN/MAX OVER TEMPERATURE				
		+25°C	+25°C	-40°C to +85°C	-40°C to +125°C	UNITS	MIN/MAX
Input Characteristics							
Input Offset Voltage (V _{OS})			0			mV	MIN
		2	4	4.5	5	mV	MAX
Input Bias Current (I _B)		1				pA	TYP
Input Offset Current (I _{OS})		1				pA	TYP
Input Common Mode Voltage Range (V _{CM})	V _S = 5.5V	-0.1 to +5.6				V	TYP
Common Mode Rejection Ratio (CMRR)	V _S = 5.5V, V _{CM} = -0.1V to 4V	82	67	66	65	dB	MIN
	V _S = 5.5V, V _{CM} = -0.1V to 5.6V	70	59	58	57	dB	MIN
Open-Loop Voltage Gain (A _{OL})	R _L = 600Ω, V _{OUT} = 0.15V to 4.85V	92	84	74	65	dB	MIN
	R _L = 10kΩ , V _{OUT} = 0.05V to 4.95V	105	96	87	72	dB	MIN
Input Offset Voltage Drift (ΔV _{OS} /ΔT)		8.7				μV/°C	TYP
Output Characteristics							
Output Voltage Swing from Rail	R _L = 600Ω	76	90	110	135	mV	MAX
	R _L = 10kΩ	7	11	13	18	mV	MAX
Output Current (I _{OUT})		63	50	41	36	mA	MIN
Closed-Loop Output Impedance	f = 1MHz, G = 1	8.5				Ω	TYP
Power Supply							
Operating Voltage Range		2.1	2.1	2.1	2.1	V	MIN
		5.5	5.5	5.5	5.5	V	MAX
Power Supply Rejection Ratio (PSRR)	V _S = +2.1V to +5.5V, V _{CM} = (-V _S) + 0.5V	79	69	68	64	dB	MIN
Quiescent Current (I _Q)	I _{OUT} = 0	2.2	2.7	3	3.5	mA	MAX
Dynamic Performance							
Gain-Bandwidth Product (GBP)	R _L = 10kΩ	11				MHz	TYP
Phase Margin (φ _O)		62				°	TYP
Full Power Bandwidth (BW _P)	< 1% distortion	400				kHz	TYP
Slew Rate (SR)	G = 1, 2V output step	8.5				V/μs	TYP
Settling Time to 0.1% (t _S)	G = 1, 2V output step	0.21				μs	TYP
Overload Recovery Time	V _{IN} × G = V _S	0.6				μs	TYP
Noise Performance							
Input Voltage Noise Density (e _n)	f = 1kHz	12.5				nV/√Hz	TYP
	f = 10kHz	8.5				nV/√Hz	TYP

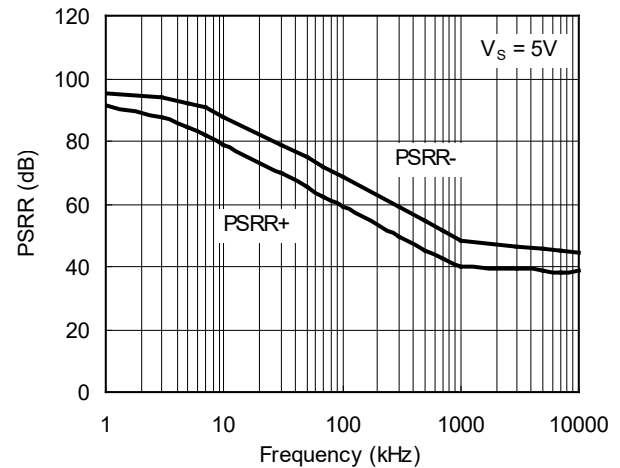
TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_{CM} = V_S/2$, $R_L = 600\Omega$, unless otherwise noted.

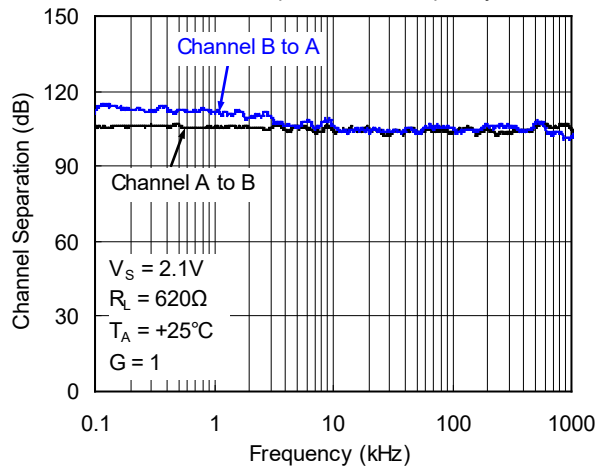
CMRR vs. Frequency



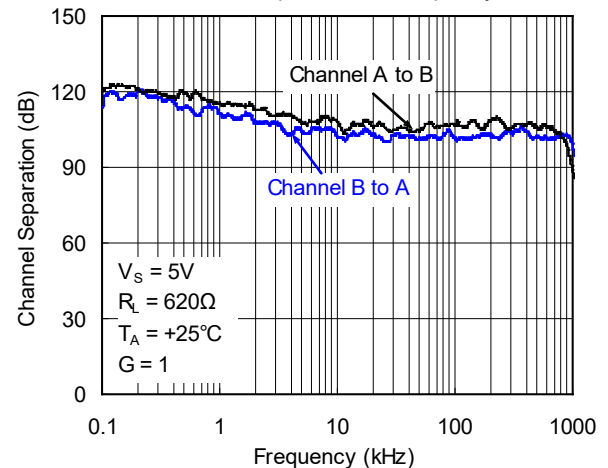
PSRR vs. Frequency



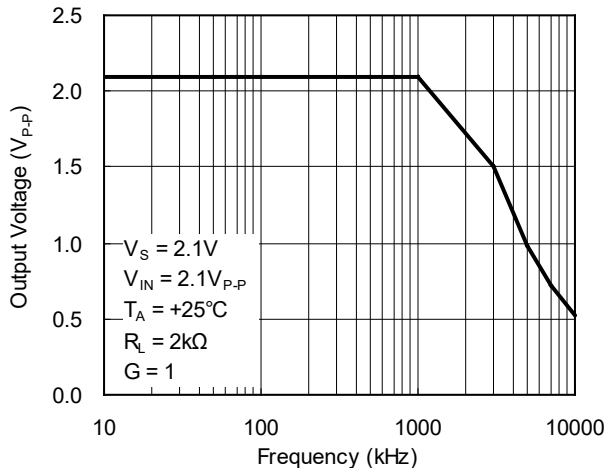
Channel Separation vs. Frequency



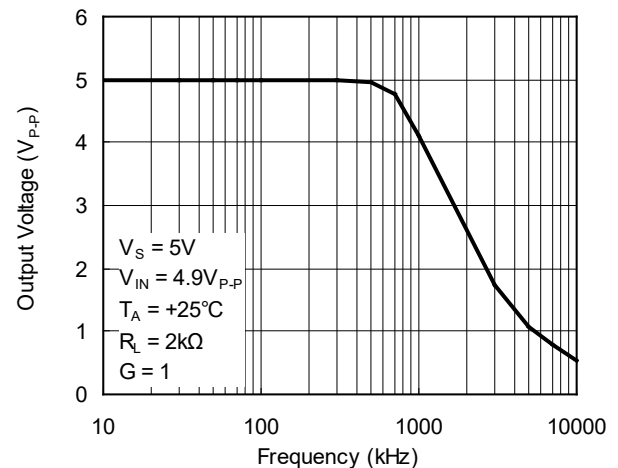
Channel Separation vs. Frequency



Closed-Loop Output Voltage Swing



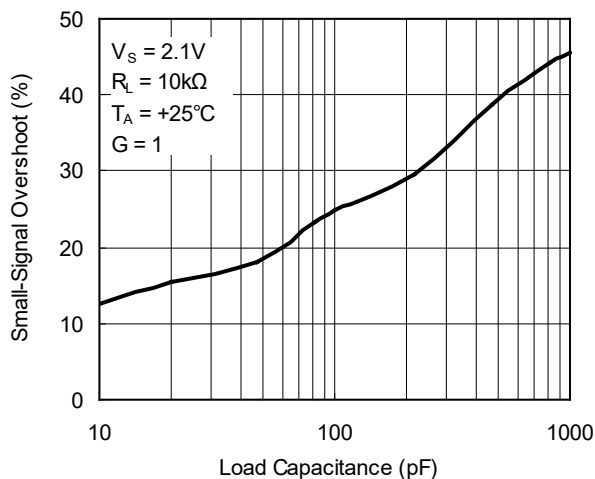
Closed-Loop Output Voltage Swing



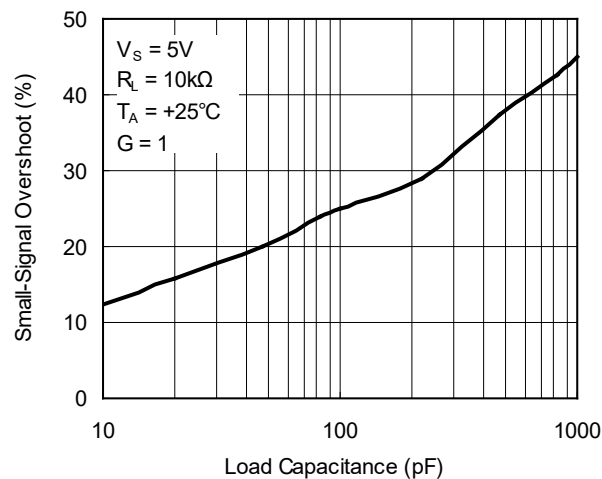
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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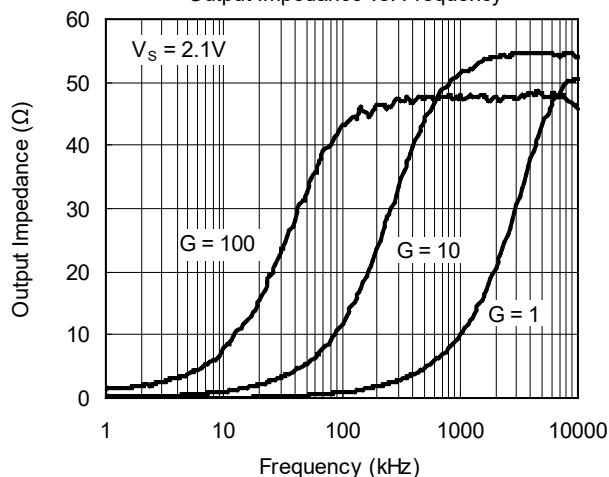
Small-Signal Overshoot vs. Load Capacitance



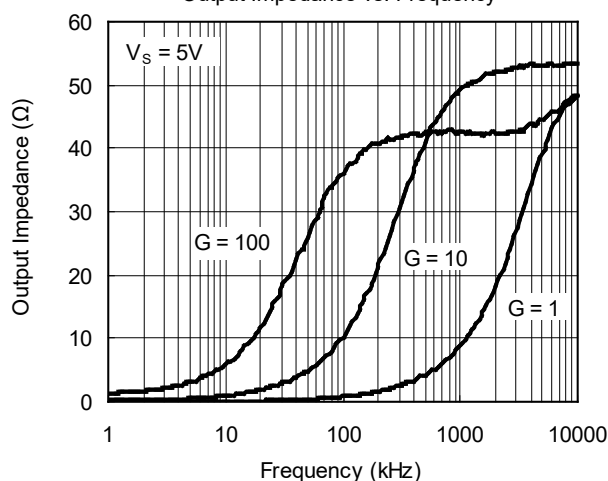
Small-Signal Overshoot vs. Load Capacitance



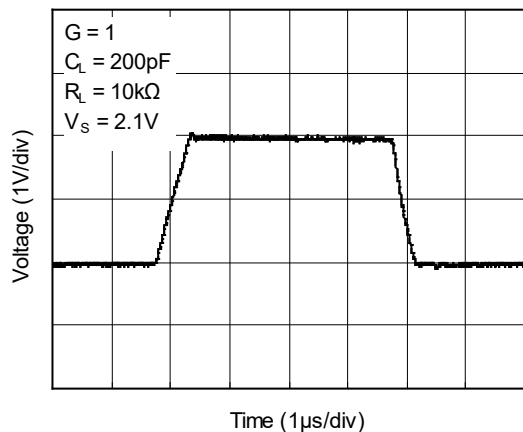
Output Impedance vs. Frequency



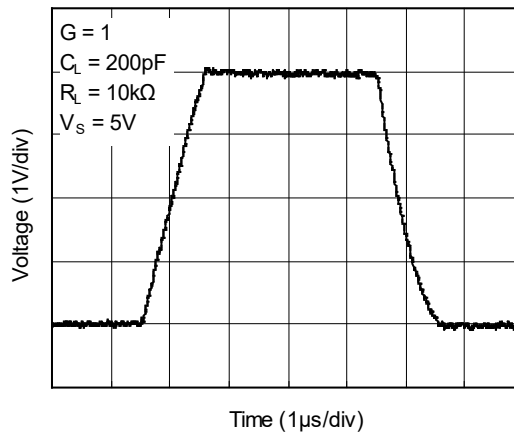
Output Impedance vs. Frequency



Large-Signal Step Response



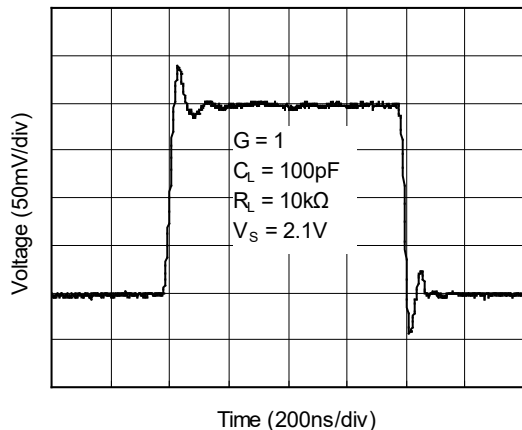
Large-Signal Step Response



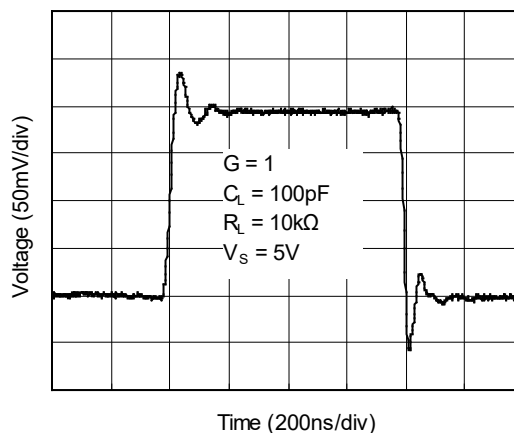
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_{CM} = V_S/2$, $R_L = 600\Omega$, unless otherwise noted.

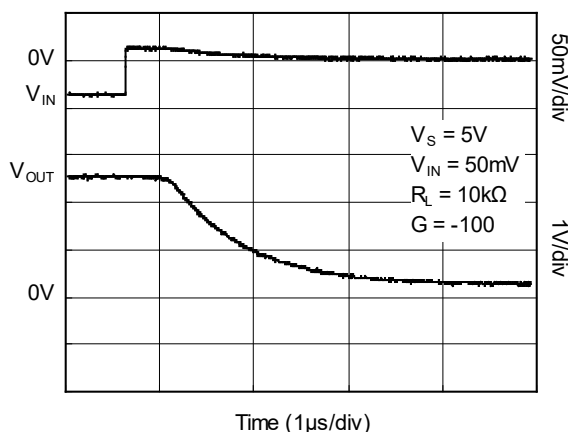
Small-Signal Step Response



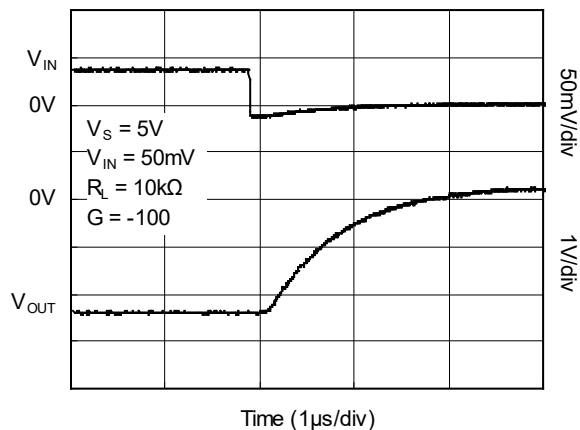
Small-Signal Step Response



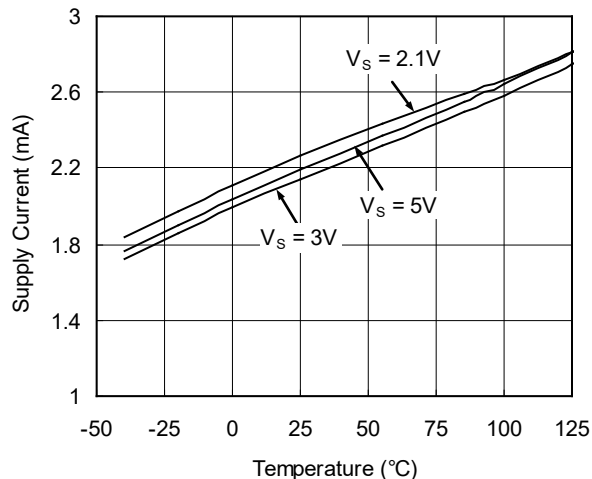
Positive Overload Recovery



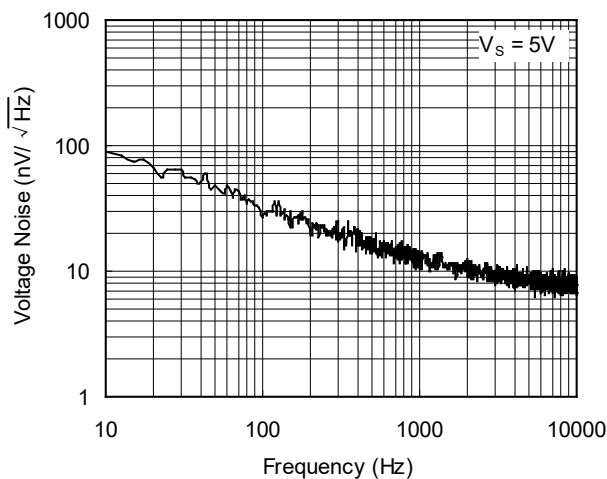
Negative Overload Recovery



Supply Current vs. Temperature



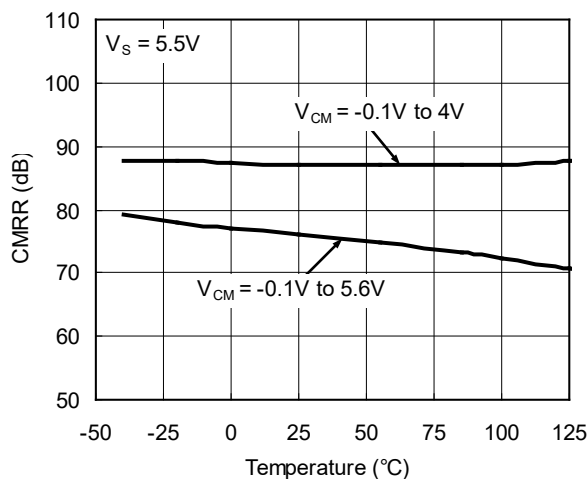
Input Voltage Noise Spectral Density vs. Frequency



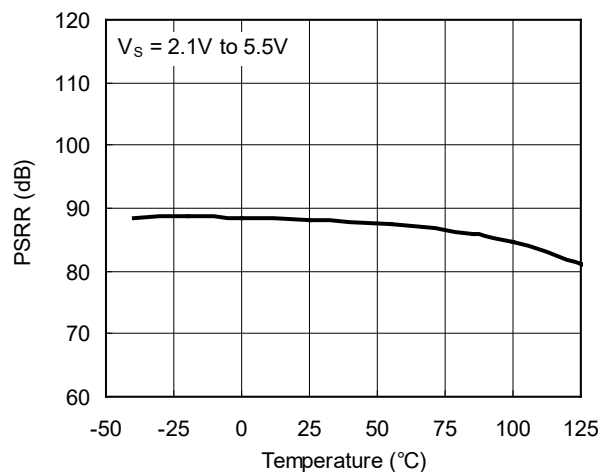
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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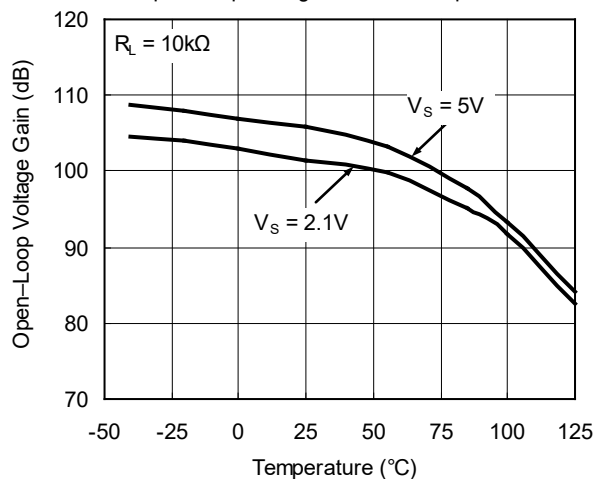
CMRR vs. Temperature



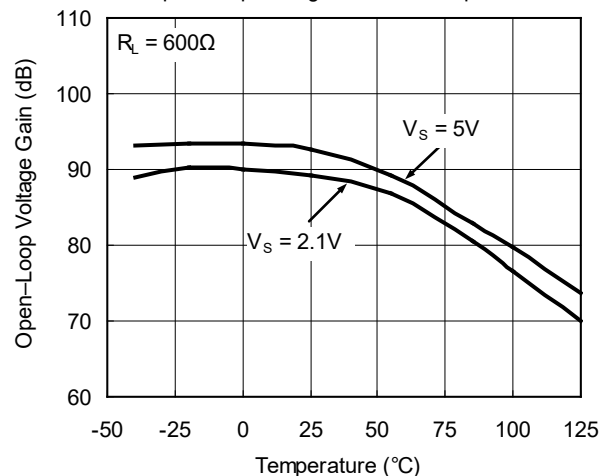
PSRR vs. Temperature



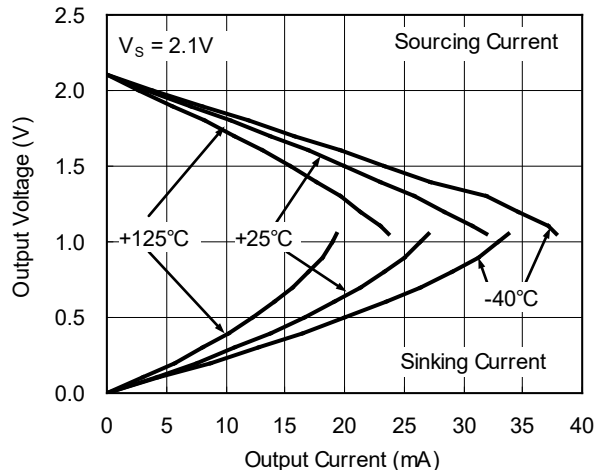
Open-Loop Voltage Gain vs. Temperature



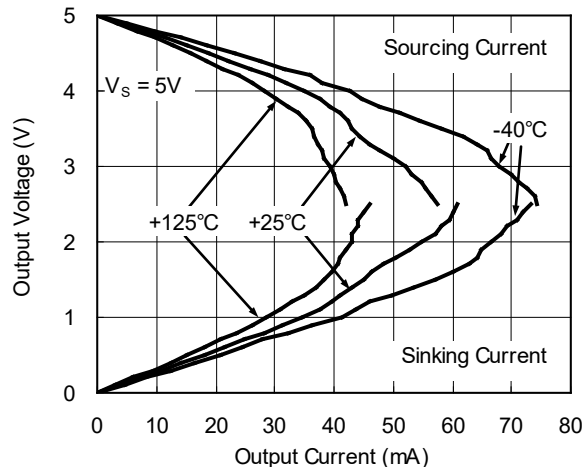
Open-Loop Voltage Gain vs. Temperature



Output Voltage Swing vs. Output Current



Output Voltage Swing vs. Output Current



APPLICATION INFORMATION

Driving Capacitive Loads

The SGM8600 can directly drive 4700pF in unity-gain without oscillation. The unity-gain follower (buffer) is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers and this results in ringing or even oscillation. Applications that require greater capacitive driving capability should use an isolation resistor between the output and the capacitive load like the circuit in Figure 1. The isolation resistor R_{ISO} and the load capacitor C_L form a zero to increase stability. The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. Note that this method results in a loss of gain accuracy because R_{ISO} forms a voltage divider with the R_{LOAD} .

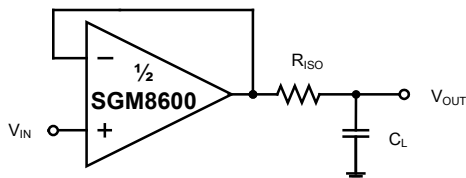


Figure 1. Indirectly Driving Heavy Capacitive Load

An improved circuit is shown Figure 2. It provides DC accuracy as well as AC stability. R_F provides the DC accuracy by connecting the inverting input with the output. C_F and R_{ISO} serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving phase margin in the overall feedback loop.

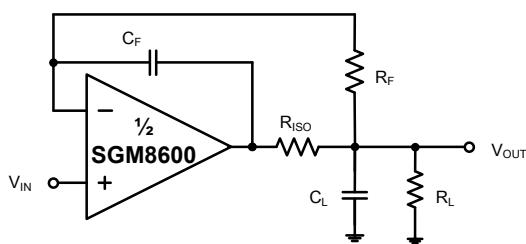


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

For non-buffer configuration, there are two other ways to increase the phase margin: (a) by increasing the amplifier's closed-loop gain or (b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node.

Power Supply Bypassing and Layout

The SGM8600 operates from either a single 2.1V to 5.5V supply or dual $\pm 1.05V$ to $\pm 2.75V$ supplies. For single-supply operation, bypass the power supply $+V_S$ with a 0.1 μF ceramic capacitor which should be placed close to the $+V_S$ pin. For dual-supply operation, both the $+V_S$ and the $-V_S$ supplies should be bypassed to ground with separate 0.1 μF ceramic capacitors. 2.2 μF tantalum capacitor can be added for better performance.

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

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

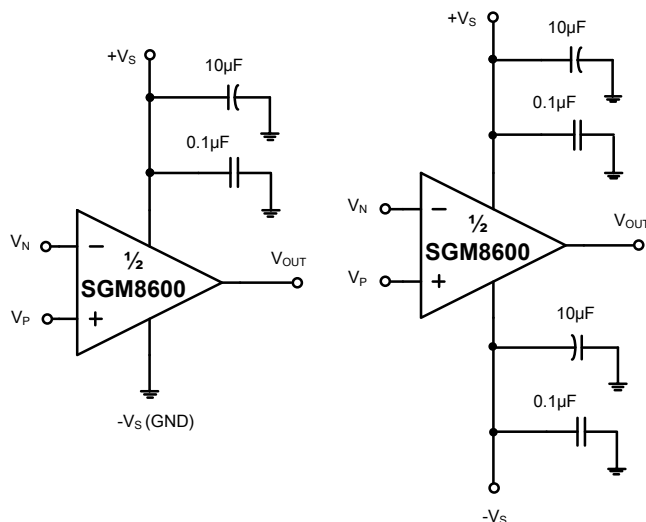


Figure 3. Amplifier with Bypass Capacitors

Grounding

A ground plane layer is important for SGM8600 circuit design. The length of the current path in an inductive ground return will create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance.

Input-to-Output Coupling

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

TYPICAL APPLICATION CIRCUITS

Differential Amplifier

The circuit shown in Figure 4 performs the difference function. If the resistor ratios are equal ($R_4/R_3 = R_2/R_1$), then $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$.

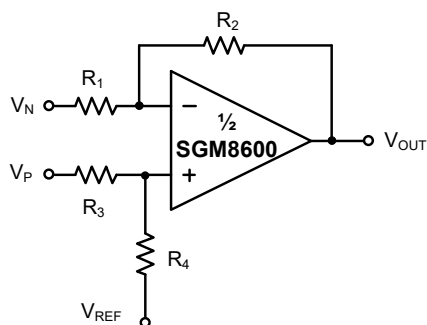


Figure 4. Differential Amplifier

Instrumentation Amplifier

The circuit in Figure 5 performs the same function as that in Figure 4 but with a high input impedance.

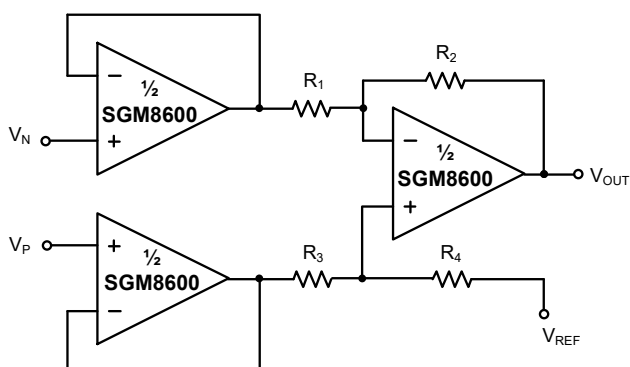


Figure 5. Instrumentation Amplifier

Active Low-Pass Filter

The low-pass filter shown in Figure 6 has a DC gain of $(-R_2/R_1)$ and the -3dB corner frequency is $1/2\pi R_2 C$. Make sure the filter bandwidth is within the bandwidth of the amplifier. Feedback resistors with large values can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistor values as low as possible and consistent with output loading consideration.

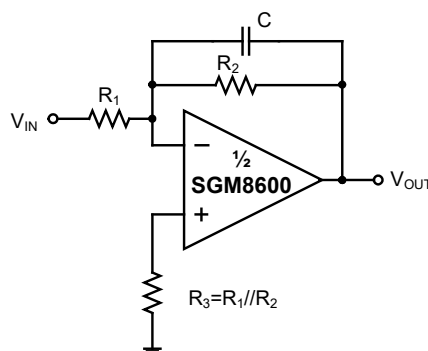


Figure 6. Active Low-Pass Filter

REVISION HISTORY

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

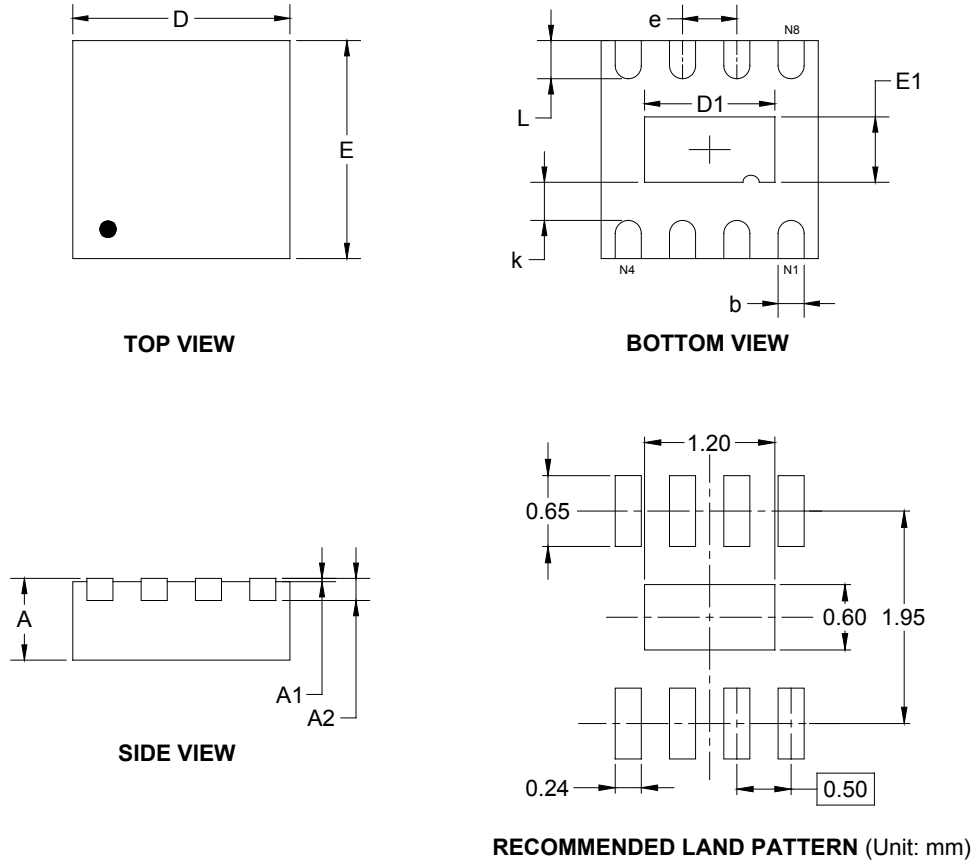
Changes from Original (SEPTEMBER 2015) to REV.A

Page

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

PACKAGE OUTLINE DIMENSIONS

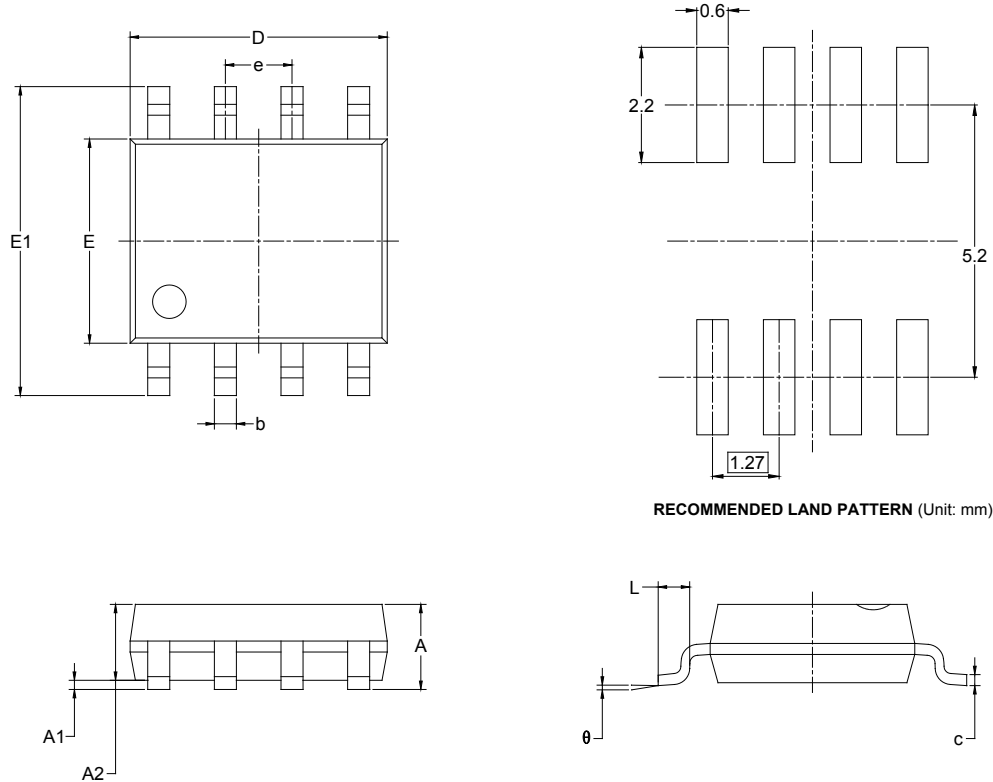
TDFN-2×2-8L



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

SOIC-8

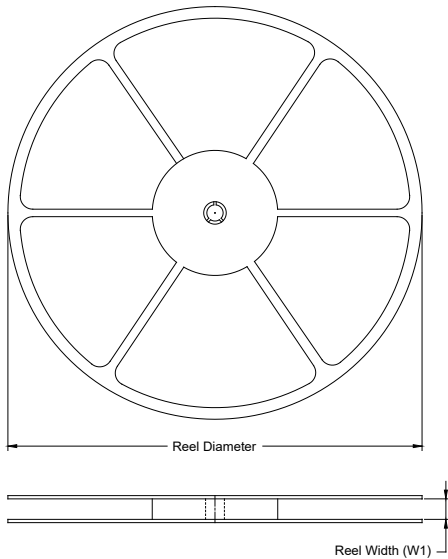


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

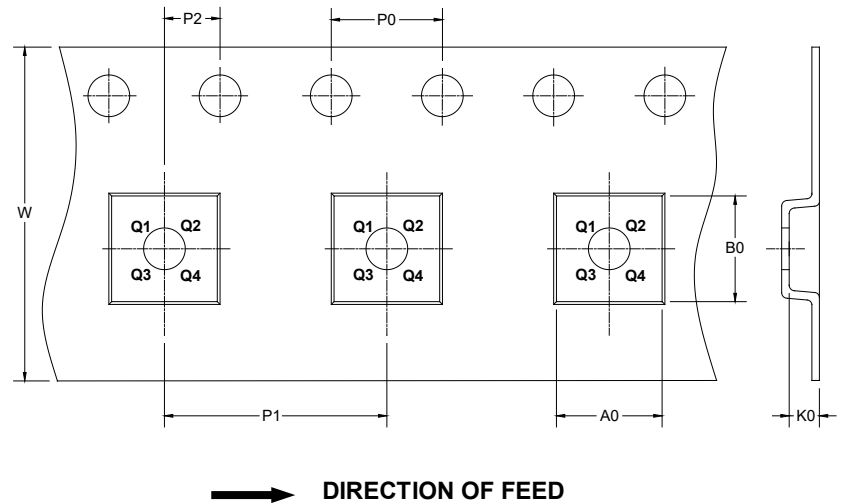
PACKAGE INFORMATION

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



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

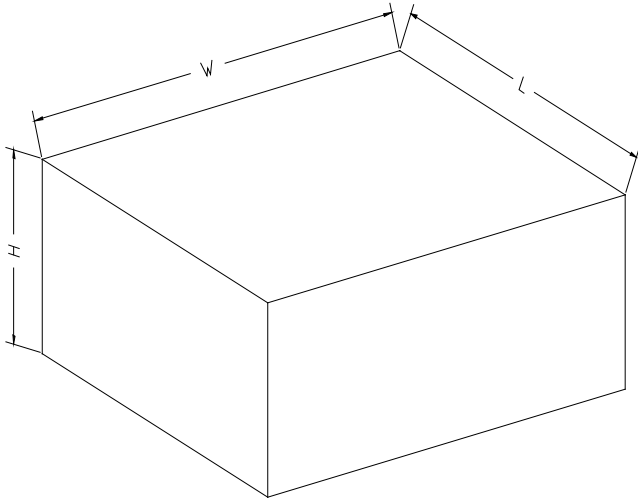
KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
TDFN-2×2-8L	7"	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q1
SOIC-8	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1

DD0001

PACKAGE INFORMATION

CARTON BOX DIMENSIONS



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

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7" (Option)	368	227	224	8
7"	442	410	224	18
13"	386	280	370	5

DD0002