



# SGM8965-1/SGM8965-2 50MHz, Low Distortion, RRIO, Single Supply Operational Amplifiers

## GENERAL DESCRIPTION

The SGM8965-1/2 zero-crossover series, rail-to-rail input and output, high-performance, CMOS operational amplifiers are optimized for low voltage, single supply applications. Rail-to-rail input and output, low noise and high speed operation make these devices ideal for driving sampling analog-to-digital converters (ADCs). Applications include audio, signal conditioning and sensor amplification. The SGM8965-1/2 family of operational amplifiers is also well-suited for cell phone power amplifier control loops.

Special features include no input stage crossover distortion, high input impedance, and rail-to-rail input and output swing. The input common mode voltage range includes both the negative and positive supplies. The output voltage swing is within 8mV of the rails.

The SGM8965-1 (single version) is available in Green SOT-23-5 and SOIC-8 packages. The SGM8965-2 (dual version) is available in Green SOIC-8 and MSOP-8 packages. All versions are specified for operation from -40°C to +125°C. Single and dual versions have identical specifications for maximum design flexibility.

## FEATURES

- **Gain Bandwidth: 50MHz**
- **Excellent THD+N: 0.00015%**
- **High CMRR: 100dB (TYP)**
- **Rail-to-Rail Input and Output:**
  - Input 100mV Beyond Supply Rail
- **Low Noise: 4.5nV/ $\sqrt{\text{Hz}}$  at 100kHz**
- **Slew Rate: 30V/ $\mu\text{s}$**
- **High Precision:**
  - Low Offset: 250 $\mu\text{V}$  (MAX)
  - Low Input Bias Current: 0.5pA (TYP)
- **Stable When Gain  $\geq 4$**
- **2.2V to 5.5V Operation Voltage Range**
- **-40°C to +125°C Operating Temperature Range**
- **Small Packaging:**
  - SGM8965-1 Available in Green SOT-23-5 and SOIC-8 Packages
  - SGM8965-2 Available in Green SOIC-8 and MSOP-8 Packages

## APPLICATIONS

Signal Conditioning  
Data Acquisition  
Process Control  
Active Filters  
Test Equipment  
Audio  
Wideband Amplifiers

**PACKAGE/ORDERING INFORMATION**

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8965-1	SOT-23-5	-40°C to +125°C	SGM8965-1XN5G/TR	SZ9XX	Tape and Reel, 3000
	SOIC-8	-40°C to +125°C	SGM8965-1XS8G/TR	SGM 89651XS8 XXXXX	Tape and Reel, 2500
SGM8965-2	SOIC-8	-40°C to +125°C	SGM8965-2XS8G/TR	SGM 89652XS8 XXXXX	Tape and Reel, 2500
	MSOP-8	-40°C to +125°C	SGM8965-2XMS8G/TR	SGM89652 XMS8 XXXXX	Tape and Reel, 4000

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

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.

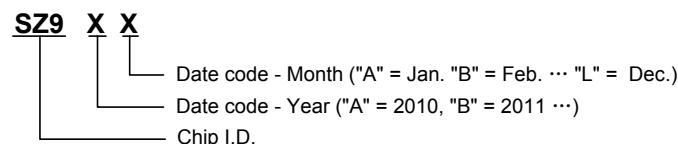
**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage.....6V  
 Signal Input Terminals, Voltage  
 ..... (-V<sub>S</sub>) - 0.3V to (+V<sub>S</sub>) + 0.3V  
 Signal Input Terminals, Current .....±10mA  
 Output Short-Circuit..... Continuous  
 Junction Temperature.....+150°C  
 Storage Temperature Range .....-65°C to +150°C  
 Lead Temperature (Soldering, 10s).....+260°C  
 ESD Susceptibility  
 HBM..... 8000V  
 MM..... 400V  
 CDM ..... 1000V

**RECOMMENDED OPERATING CONDITIONS**

Supply Voltage Range .....2.2V to 5.5V  
 Operating Temperature Range .....-40°C to +125°C

**MARKING INFORMATION**



For example: SZ9EA (2014, January)

**OVERSTRESS CAUTION**

Stresses beyond those listed may cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational section of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

**ESD SENSITIVITY CAUTION**

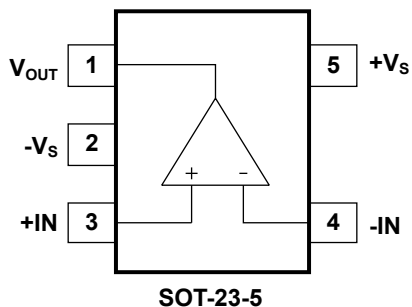
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

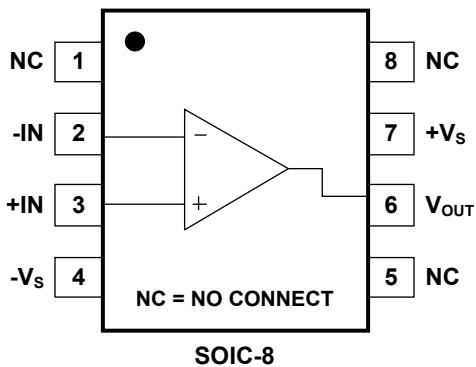
SG Micro Corp reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time.

**PIN CONFIGURATIONS**

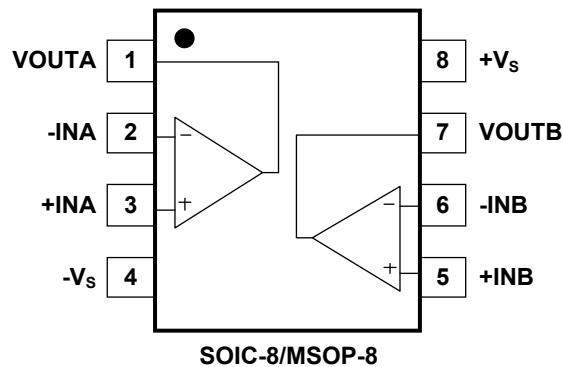
**SGM8965-1 (TOP VIEW)**



**SGM8965-1 (TOP VIEW)**



**SGM8965-2 (TOP VIEW)**



## ELECTRICAL CHARACTERISTICS

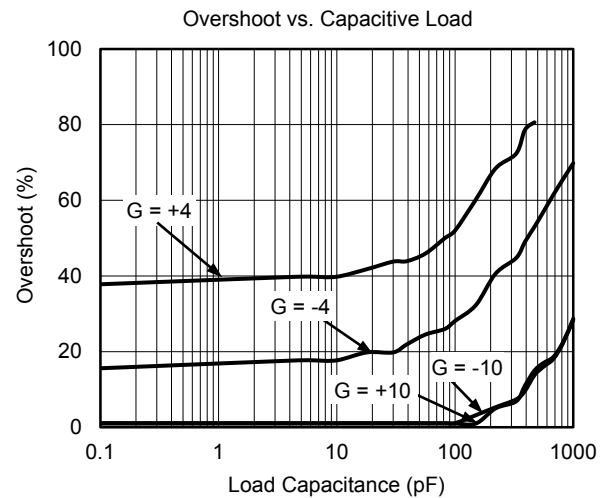
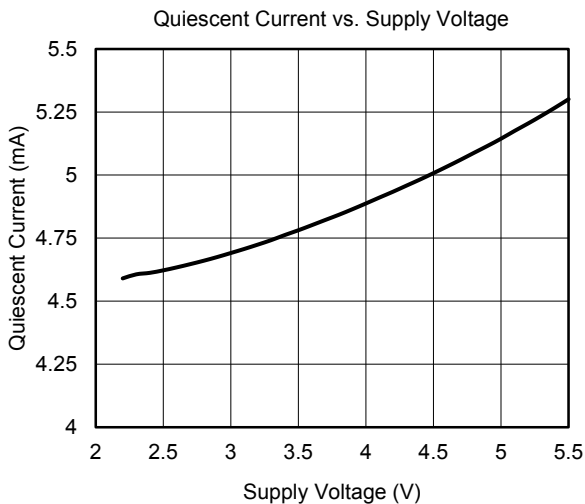
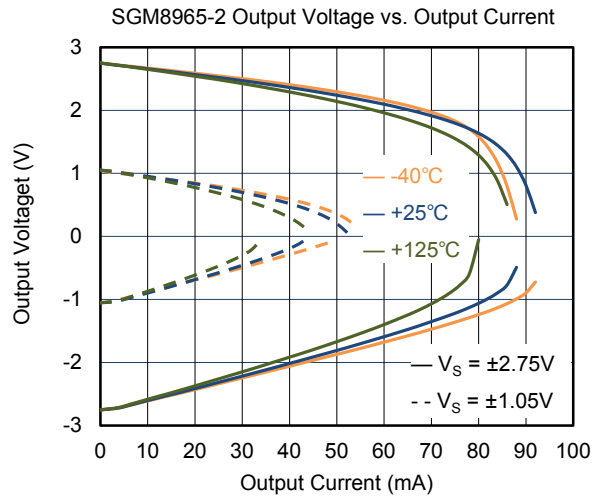
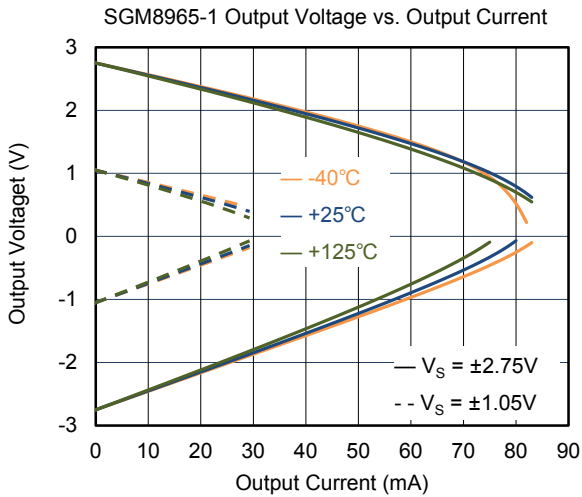
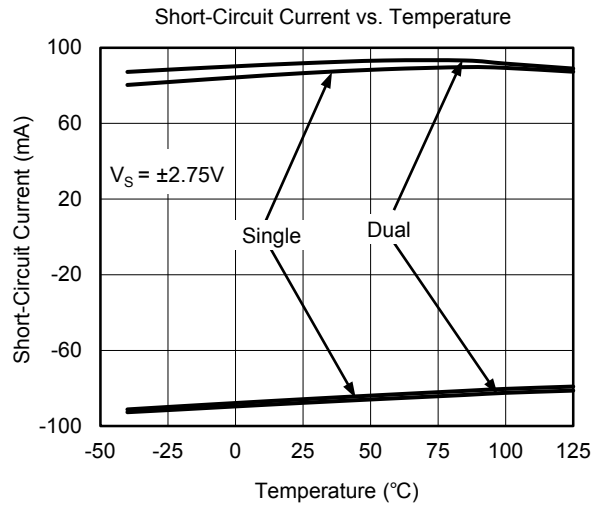
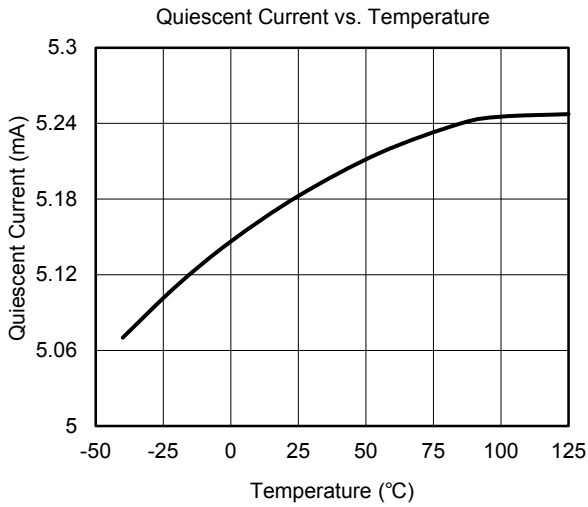
(At  $T_A = +25^\circ\text{C}$ ,  $V_S = 2.2\text{V}$  to  $5.5\text{V}$ ,  $V_{CM} = V_S/2$ ,  $V_{OUT} = V_S/2$  and  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
<b>INPUT CHARACTERISTICS</b>						
Input Offset Voltage	$V_{OS}$			80	250	$\mu\text{V}$
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		1.2		$\mu\text{V}/^\circ\text{C}$
Power Supply Rejection Ratio	PSRR	$V_S = 2.2\text{V}$ to $5.5\text{V}$ , $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		6	90	$\mu\text{V}/\text{V}$
Input Bias Current	$I_B$			0.5		$\text{pA}$
Input Common Mode Voltage Range	$V_{CM}$		$(-V_S) - 0.1$		$(+V_S) + 0.1$	$\text{V}$
Common Mode Rejection Ratio	CMRR	$(-V_S) - 0.1\text{V} \leq V_{CM} \leq (+V_S) + 0.1\text{V}$ , $V_S = 5.5\text{V}$ , $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	82	100		$\text{dB}$
Open-Loop Voltage Gain	$A_{OL}$	$R_L = 10\text{k}\Omega$ , $(-V_S) + 0.1\text{V} < V_O < (+V_S) - 0.1\text{V}$ , $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	94	115		$\text{dB}$
		$R_L = 600\Omega$ , $(-V_S) + 0.2\text{V} < V_O < (+V_S) - 0.2\text{V}$ $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	94	105		
		$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$	90			
<b>OUTPUT CHARACTERISTICS</b>						
Output Voltage Swing from Rail		$R_L = 10\text{k}\Omega$ , $V_S = 5.5\text{V}$ , $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		8	22	$\text{mV}$
Short-Circuit Current	$I_{SC}$	$V_S = 5\text{V}$		70		$\text{mA}$
Open-Loop Output Impedance		$f = 1\text{MHz}$ , $I_O = 0$		26		$\Omega$
<b>POWER SUPPLY</b>						
Operating Voltage Range	$V_S$		2.2		5.5	$\text{V}$
Quiescent Current/Amplifier	$I_Q$	$I_O = 0$		5.3	6.6	$\text{mA}$
		$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$			6.9	
<b>DYNAMIC PERFORMANCE</b>						
Gain-Bandwidth Product	GBP	$V_S = 5\text{V}$		50		$\text{MHz}$
Slew Rate	SR	$V_S = 5\text{V}$ , $G = +1$		30		$\text{V}/\mu\text{s}$
Settling Time to 0.1%	$t_s$	$V_S = 5\text{V}$ , 4V Step, $G = +4$		220		$\text{ns}$
Settling Time to 0.01%		$V_S = 5\text{V}$ , 4V Step, $G = +4$		300		$\text{ns}$
Overload Recovery Time		$V_S = 5\text{V}$ , $V_{IN} \times \text{Gain} > V_S$		< 0.1		$\mu\text{s}$
Total Harmonic Distortion + Noise <sup>(1)</sup>	THD+N	$V_S = 5\text{V}$ , $R_L = 600\Omega$ , $V_O = 4V_{PP}$ , $G = +1$ , $f = 1\text{kHz}$		0.00015		$\%$
<b>NOISE PERFORMANCE</b>						
Input Voltage Noise		$f = 0.1\text{Hz}$ to $10\text{Hz}$		5		$\mu\text{V}_{PP}$
Input Voltage Noise Density	$e_n$	$f = 100\text{kHz}$		4.5		$\text{nV}/\sqrt{\text{Hz}}$
Input Current Noise Density	$i_n$	$f = 10\text{kHz}$		125		$\text{fA}/\sqrt{\text{Hz}}$

NOTE: 1. 3rd-order filter; bandwidth 80kHz at -3dB.

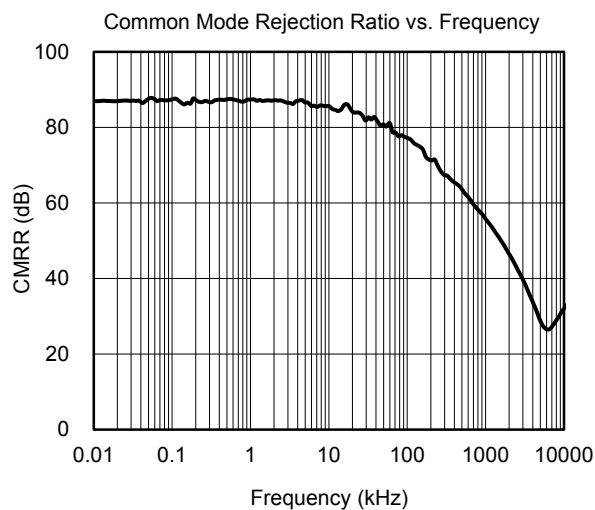
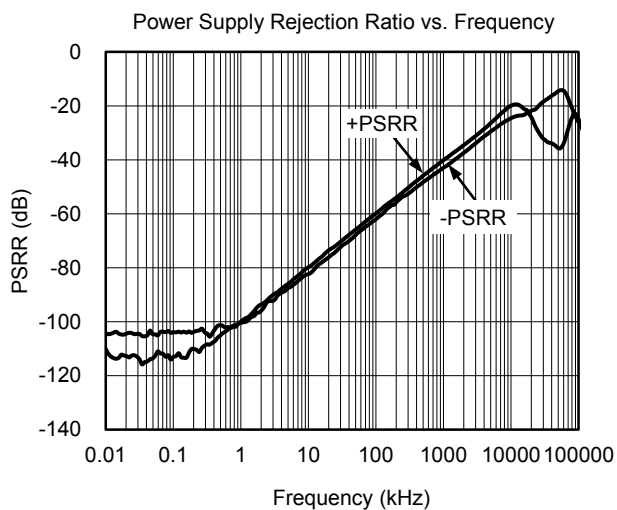
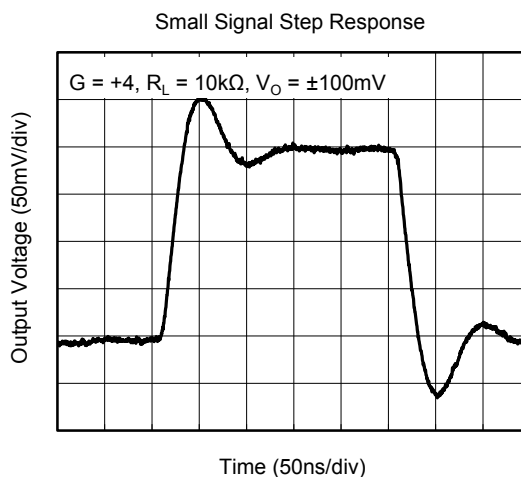
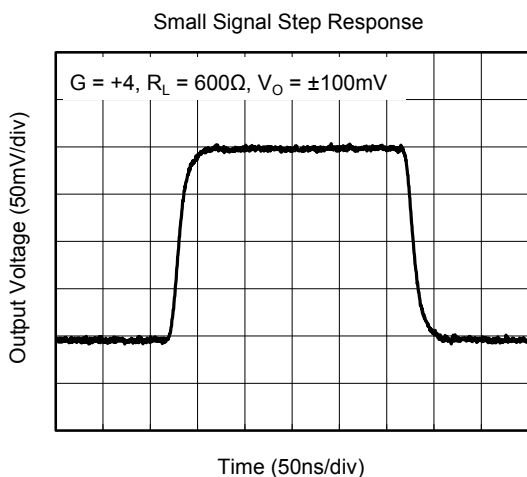
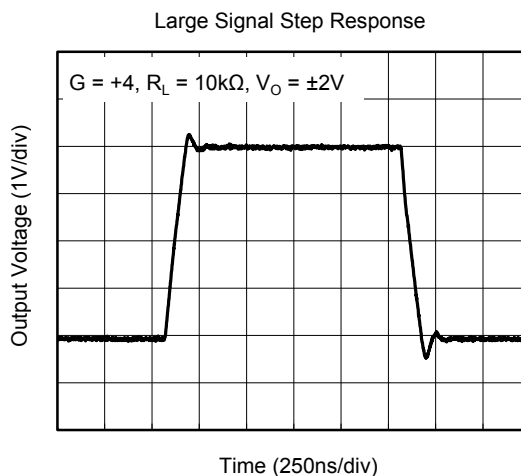
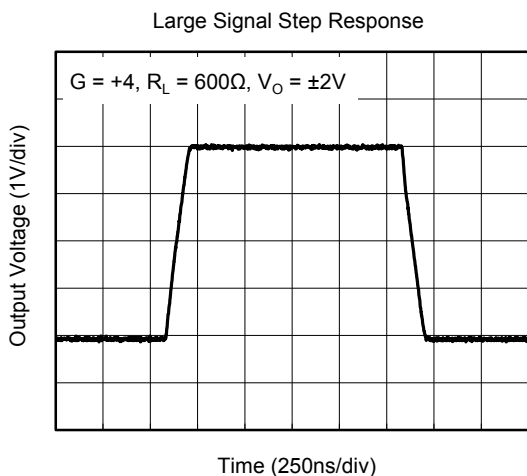
**TYPICAL PERFORMANCE CHARACTERISTICS**

$V_S = 5V$ , and  $C_L = 0pF$ , typical values are at  $T_A = +25^\circ C$ , unless otherwise noted.



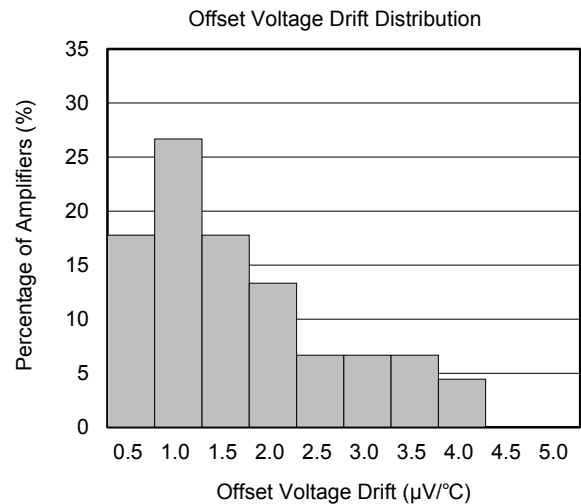
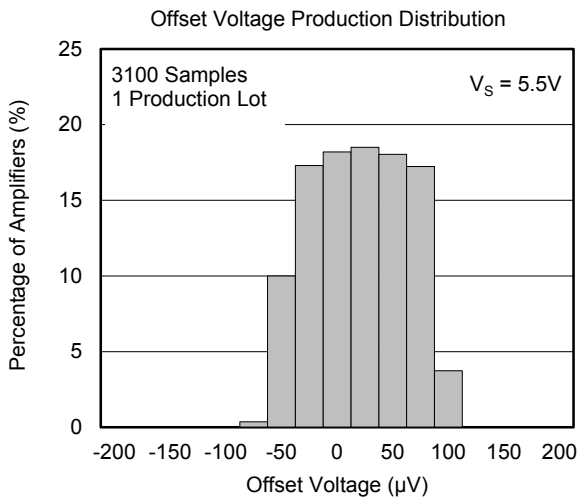
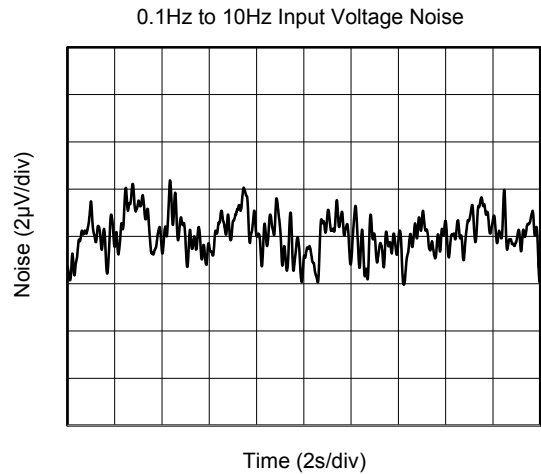
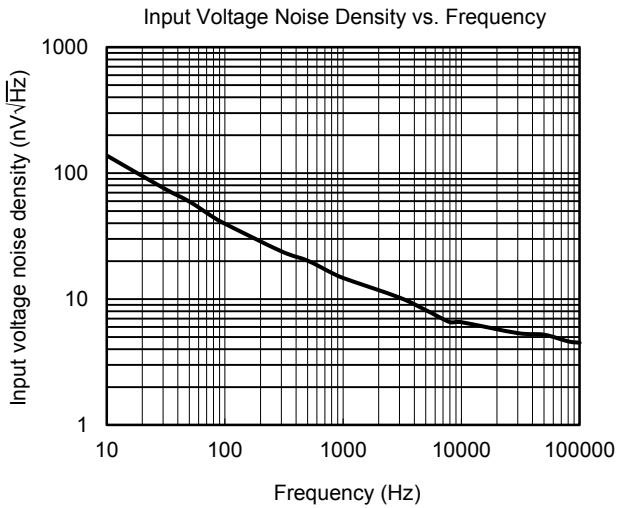
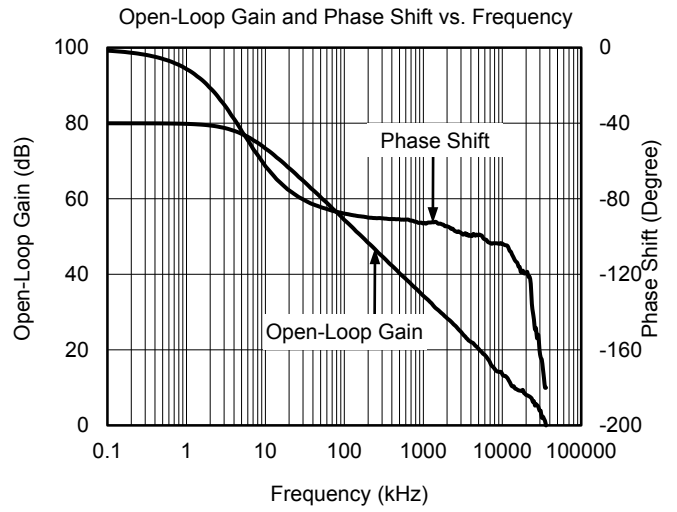
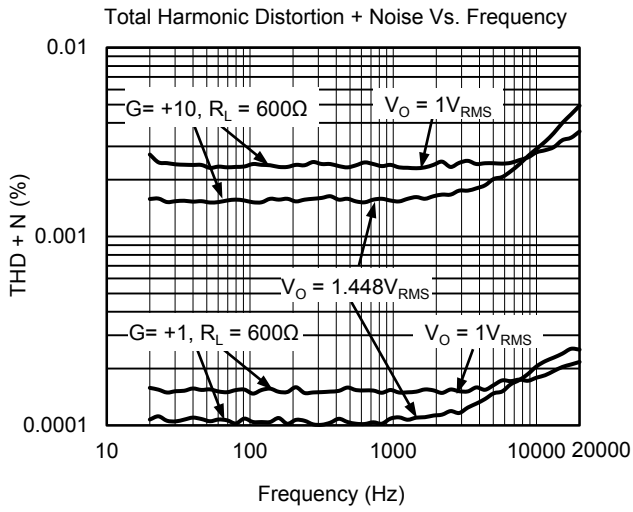
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

$V_S = 5V$ , and  $C_L = 0pF$ ,  $T_A = +25^\circ C$ , unless otherwise noted.



**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

$V_S = 5V$ , and  $C_L = 0pF$ , typical values are at  $T_A = +25^\circ C$ , unless otherwise noted.

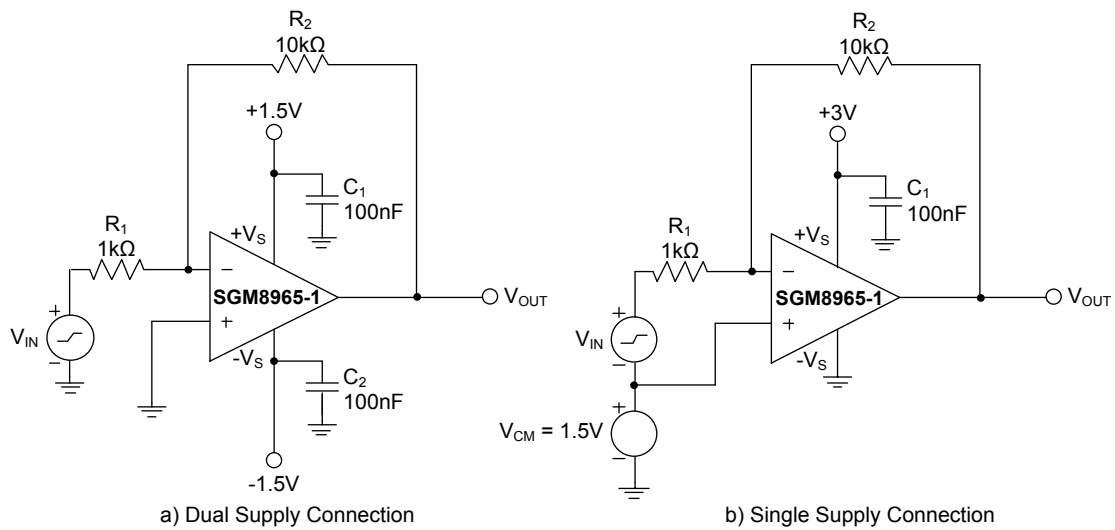


**APPLICATION INFORMATION**

**Basic Amplifier Configurations**

As with other single supply operational amplifiers, the SGM8965-1/2 may be operated with either a single supply or dual supplies. A typical dual supply connection is shown in Figure 1, which is accompanied by a single supply connection. The SGM8965-1 is configured as a basic inverting amplifier with a gain of  $-10V/V$ . The dual supply connection has an output voltage centered on zero, while the single supply

connection has an output centered on the common mode voltage  $V_{CM}$ . For the circuit shown, this voltage is 1.5V, but may be any value within the input common mode voltage range. The SGM8965-1  $V_{CM}$  range extends 100mV beyond the power-supply rails.

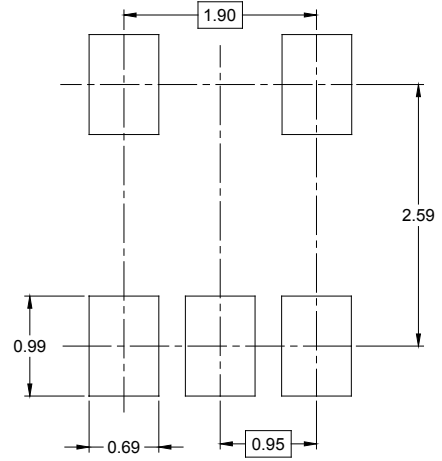


**Figure 1. Basic Circuit Connections**



PACKAGE OUTLINE DIMENSIONS

SOT-23-5



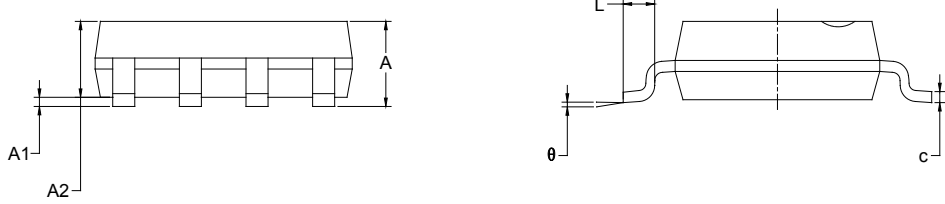
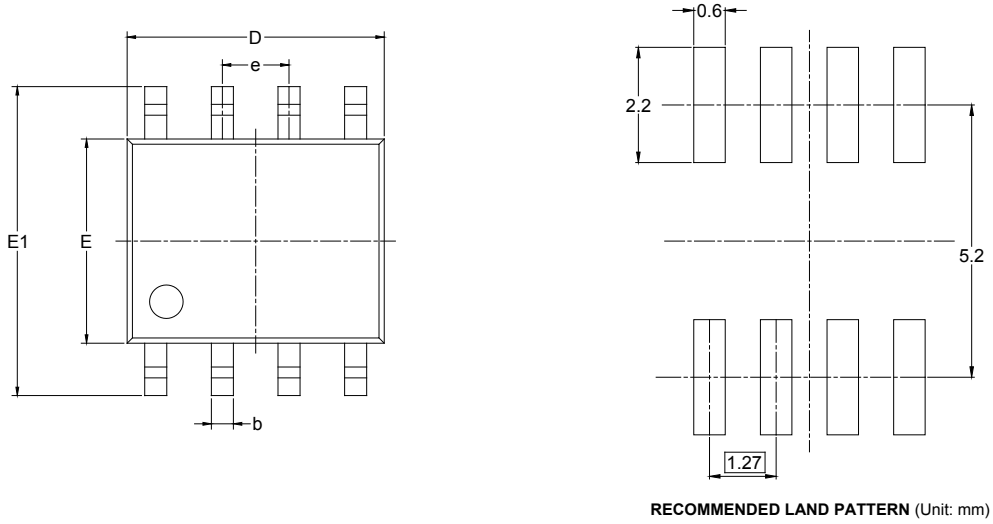
RECOMMENDED LAND PATTERN (Unit: mm)



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
$\theta$	0°	8°	0°	8°

PACKAGE OUTLINE DIMENSIONS

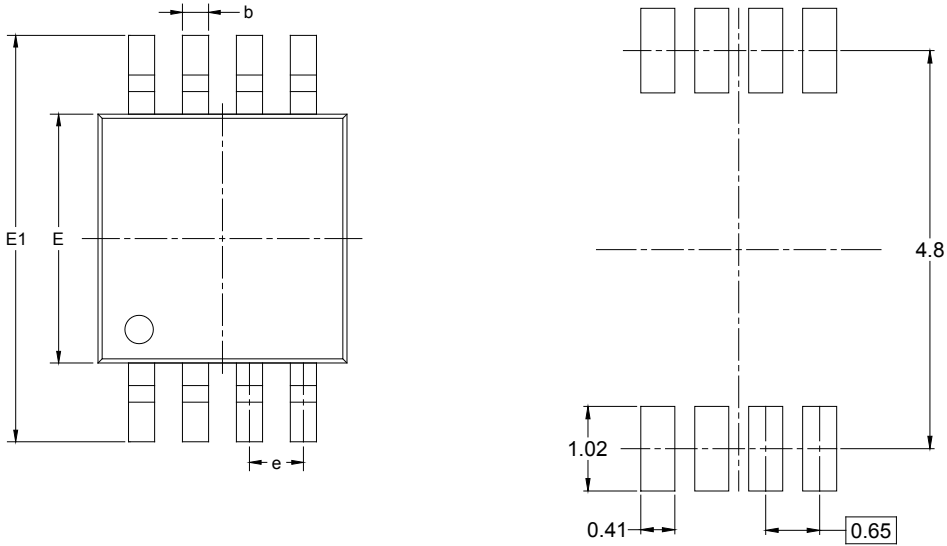
SOIC-8



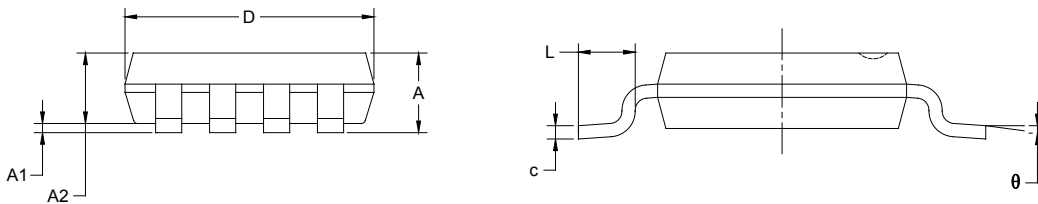
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

PACKAGE OUTLINE DIMENSIONS

MSOP-8



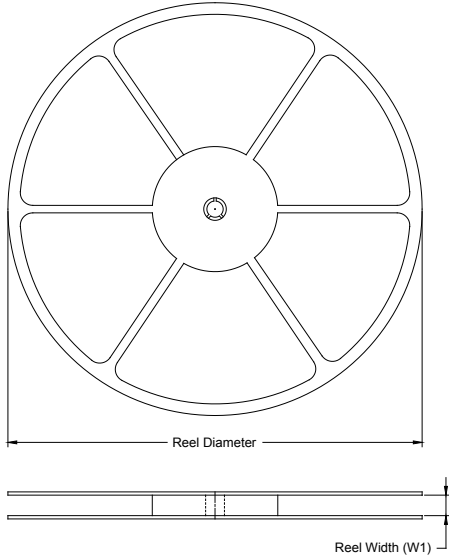
RECOMMENDED LAND PATTERN (Unit: mm)



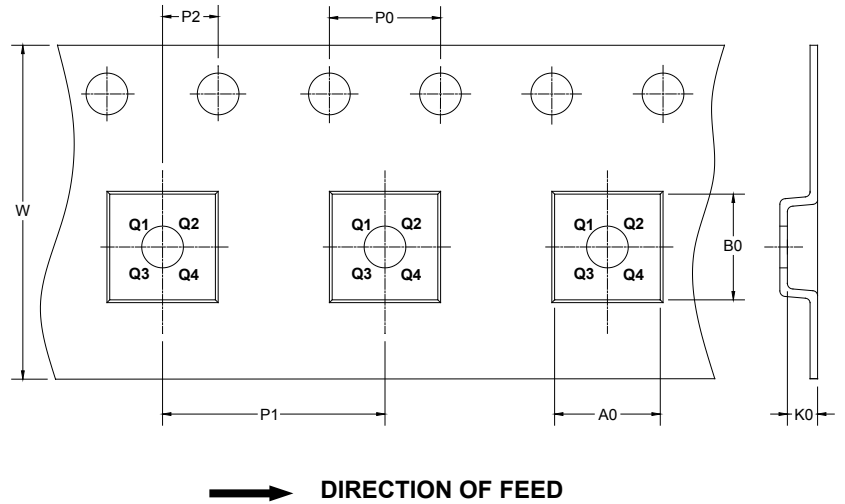
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

## TAPE AND REEL INFORMATION

### REEL DIMENSIONS



### TAPE DIMENSIONS



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

### KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT-23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOIC-8	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP-8	13"	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1

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