



# SGM8965A-1/SGM8965A-2 50MHz, Low Distortion, Rail-to-Rail I/O, Single-Supply Operational Amplifiers

## GENERAL DESCRIPTION

The single SGM8965A-1 and dual SGM8965A-2 are high speed CMOS operational amplifiers with high input impedance, zero-crossover and low distortion. These devices can operate from 2.2V to 5.5V single supply.

The SGM8965A-1/2 feature high speed and low noise. They support rail-to-rail input and output operation. The input common mode voltage range is from  $(-V_S) - 0.1V$  to  $(+V_S) + 0.1V$ , and the output range is from  $(-V_S) + 0.006V$  to  $(+V_S) - 0.006V$ . Furthermore, the SGM8965A-1/2 provide high CMRR with zero-crossover and low distortion, which are designed to drive ADCs with high linearity. These devices can be used in a variety of applications, such as audio, mobile phone and signal conditioning.

The SGM8965A-1 is available in Green SOT-23-5 and SOIC-8 packages. The SGM8965A-2 is available in Green SOIC-8 and MSOP-8 packages. They are specified over the extended  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$  temperature range.

## FEATURES

- **Unity-Gain Stable**
- **Gain-Bandwidth Product: 50MHz**
- **Slew Rate: 30V/ $\mu\text{s}$**
- **High CMRR: 94dB (TYP)**
- **Low Offset Voltage: 50 $\mu\text{V}$  (TYP), 280 $\mu\text{V}$  (MAX)**
- **Low Bias Current: 1pA (TYP)**
- **Low Input Voltage Noise: 5.5nV/ $\sqrt{\text{Hz}}$  at 100kHz**
- **Rail-to-Rail Input and Output**
- **Supply Voltage Range: 2.2V to 5.5V**
- **$-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$  Operating Temperature Range**
- **Small Packaging:**
  - **SGM8965A-1 Available in Green SOT-23-5 and SOIC-8 Packages**
  - **SGM8965A-2 Available in Green SOIC-8 and MSOP-8 Packages**

## APPLICATIONS

Audio  
Active Filter  
Signal Conditioning  
Sensor Amplification  
Data Acquisition  
Process Control  
Test Equipment  
Wideband Amplifier

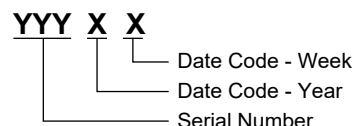
**PACKAGE/ORDERING INFORMATION**

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8965A-1	SOT-23-5	-40°C to +125°C	SGM8965A-1XN5G/TR	MLEXX	Tape and Reel, 3000
	SOIC-8	-40°C to +125°C	SGM8965A-1XS8G/TR	SGM MLCXS8 XXXXX	Tape and Reel, 4000
SGM8965A-2	SOIC-8	-40°C to +125°C	SGM8965A-2XS8G/TR	SGM MLBXS8 XXXXX	Tape and Reel, 4000
	MSOP-8	-40°C to +125°C	SGM8965A-2XMS8G/TR	SGMMLD XMS8 XXXXX	Tape and Reel, 4000

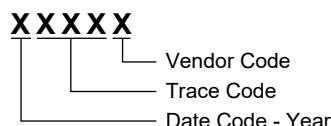
**MARKING INFORMATION**

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

**SOT-23-5**



**SOIC-8/MSOP-8**



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 Voltage Range..... (-V<sub>S</sub>) - 0.3V to (+V<sub>S</sub>) + 0.3V
- Input Current (All pins except power supply pins)..... ±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 (SGM8965A-1)..... 5000V
- HBM (SGM8965A-2)..... 7000V
- CDM..... 2000V

**RECOMMENDED OPERATING CONDITIONS**

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

**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**

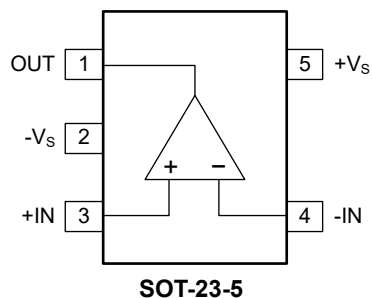
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

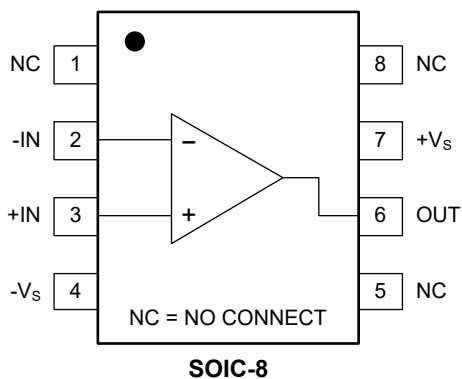
SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

**PIN CONFIGURATIONS**

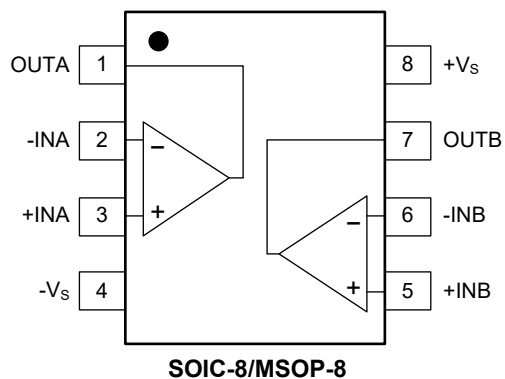
**SGM8965A-1 (TOP VIEW)**



**SGM8965A-1 (TOP VIEW)**



**SGM8965A-2 (TOP VIEW)**



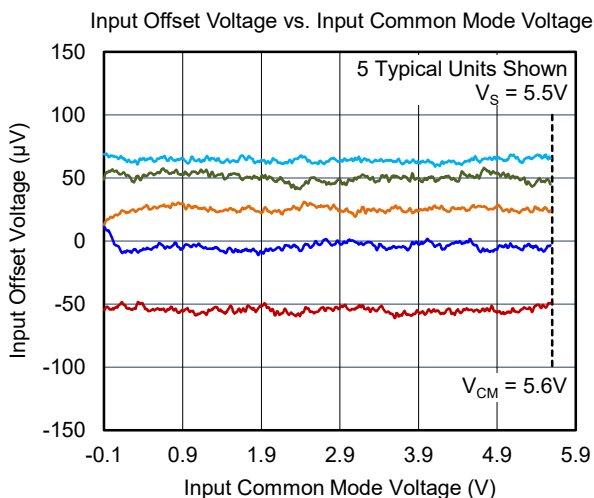
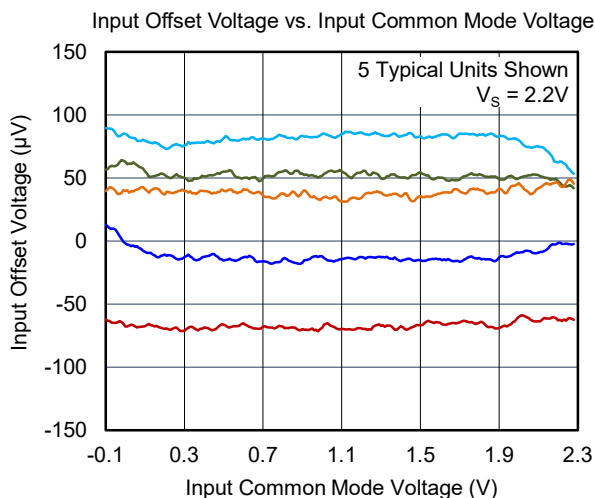
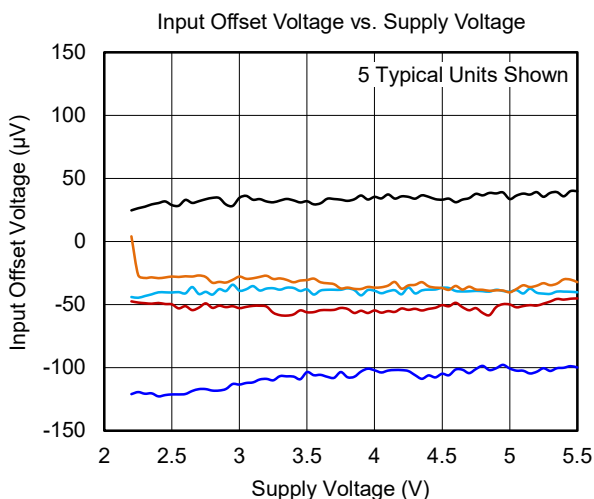
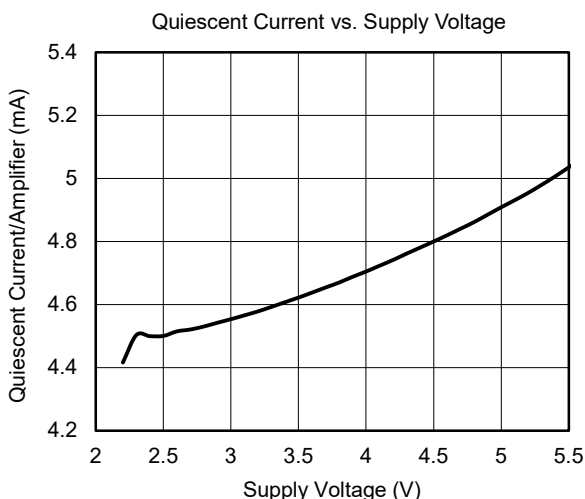
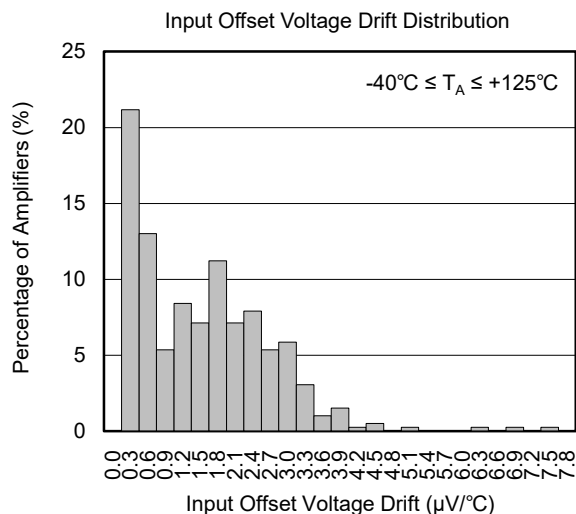
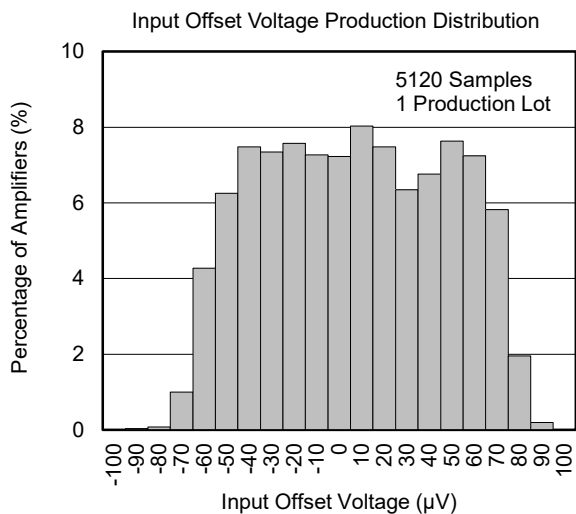
**ELECTRICAL CHARACTERISTICS**

(At T<sub>A</sub> = +25°C, V<sub>S</sub> = 2.2V to 5.5V, V<sub>CM</sub> = V<sub>S</sub>/2, V<sub>OUT</sub> = V<sub>S</sub>/2 and R<sub>L</sub> = 10kΩ connected to V<sub>S</sub>/2, Full = -40°C to +125°C, unless otherwise noted.)

PARAMETER	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
<b>Input Characteristics</b>						
Input Offset Voltage (V <sub>OS</sub> )		+25°C		50	280	μV
		Full			1000	
Input Offset Voltage Drift (ΔV <sub>OS</sub> /ΔT)		Full		1.4		μV/°C
Input Bias Current (I <sub>B</sub> )		Full		1	2800	pA
Input Offset Current (I <sub>OS</sub> )		Full		1	180	pA
Input Common Mode Voltage Range (V <sub>CM</sub> )		Full	(-V <sub>S</sub> ) - 0.1		(+V <sub>S</sub> ) + 0.1	V
Common Mode Rejection Ratio (CMRR)	(-V <sub>S</sub> ) - 0.1V ≤ V <sub>CM</sub> ≤ (+V <sub>S</sub> ) + 0.1V	+25°C	77	94		dB
		Full	68			
Open-Loop Voltage Gain (A <sub>OL</sub> )	R <sub>L</sub> = 600Ω, 200mV < V <sub>OUT</sub> < (+V <sub>S</sub> ) - 200mV	+25°C	91	118		dB
		Full	88			
	R <sub>L</sub> = 10kΩ, 100mV < V <sub>OUT</sub> < (+V <sub>S</sub> ) - 100mV	+25°C	92	118		
		Full	89			
<b>Output Characteristics</b>						
Output Voltage Swing from Rail	R <sub>L</sub> = 10kΩ, V <sub>S</sub> = 5.5V	Full		6	12	mV
Output Short-Circuit Current (I <sub>SC</sub> )	V <sub>S</sub> = 5.5V	+25°C		85		mA
Open-Loop Output Impedance	f = 1MHz, I <sub>OUT</sub> = 0A	+25°C		30		Ω
<b>Power Supply</b>						
Specified Voltage Range (V <sub>S</sub> )		Full	2.2		5.5	V
Quiescent Current/Amplifier (I <sub>Q</sub> )	I <sub>OUT</sub> = 0A	+25°C		5	6.5	mA
		Full			6.7	
Power Supply Rejection Ratio (PSRR)		Full		4	70	μV/V
<b>Dynamic Performance</b>						
Gain-Bandwidth Product (GBP)	R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 10pF	+25°C		50		MHz
Phase Margin (φ <sub>o</sub> )	R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 10pF	+25°C		55		°
Slew Rate (SR)	G = +1	+25°C		30		V/μs
Settling Time to 0.1%	4V step, G = -1	+25°C		380		ns
Settling Time to 0.01%	4V step, G = -1	+25°C		650		ns
Overload Recovery Time	V <sub>IN</sub> × G > V <sub>S</sub>	+25°C		< 0.1		μs
Total Harmonic Distortion + Noise (THD+N)	R <sub>L</sub> = 600Ω, V <sub>OUT</sub> = 4V <sub>P-P</sub> , G = +1, f = 1kHz	+25°C		0.00018		%
<b>Noise</b>						
Input Voltage Noise	f = 0.1Hz to 10Hz	+25°C		9		μV <sub>P-P</sub>
Input Voltage Noise Density (e <sub>n</sub> )	f = 100kHz	+25°C		5.5		nV/√Hz
Input Current Noise Density (i <sub>n</sub> )	f = 10kHz	+25°C		20		fA/√Hz

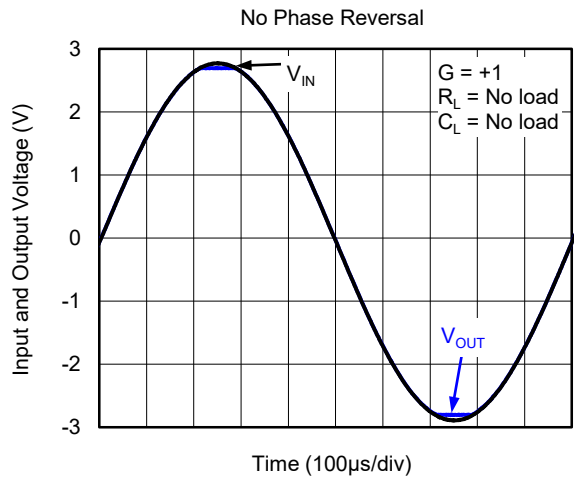
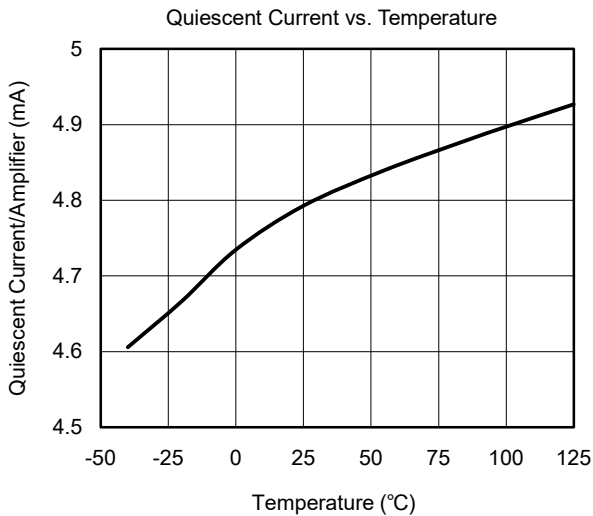
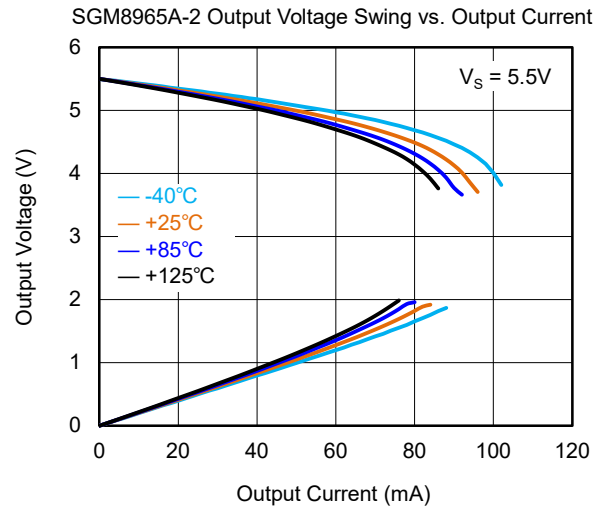
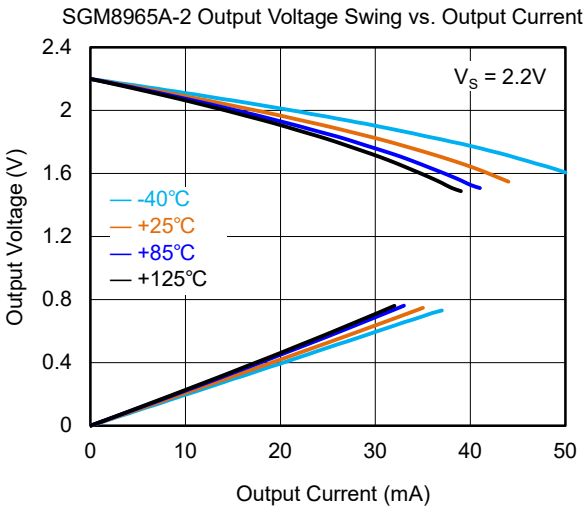
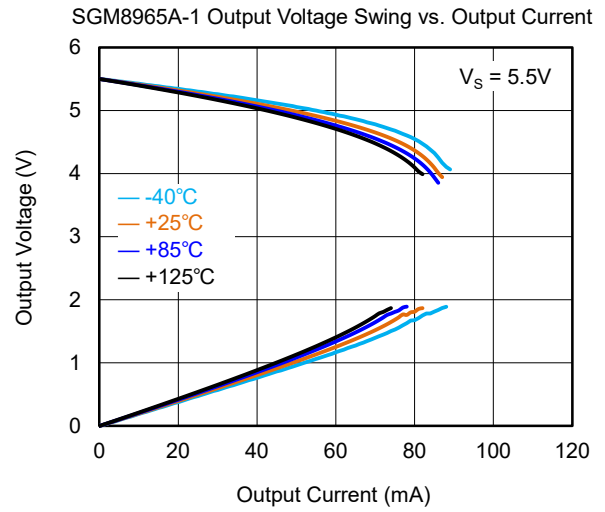
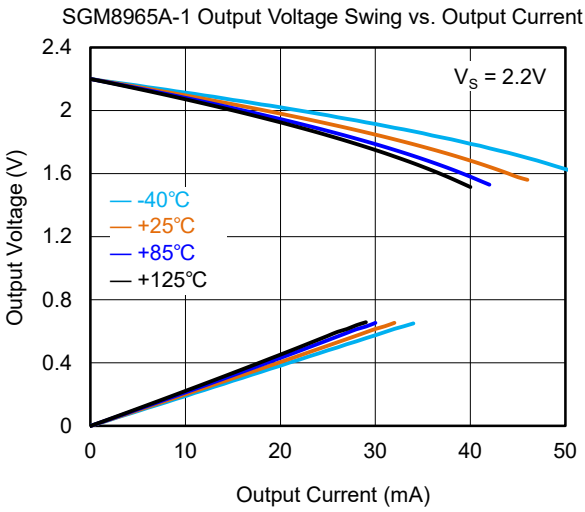
**TYPICAL PERFORMANCE CHARACTERISTICS**

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_L = 10\text{k}\Omega$  and  $C_L = 10\text{pF}$ , unless otherwise noted.



**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

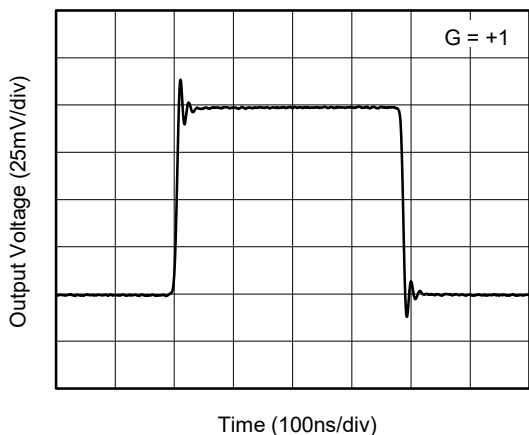
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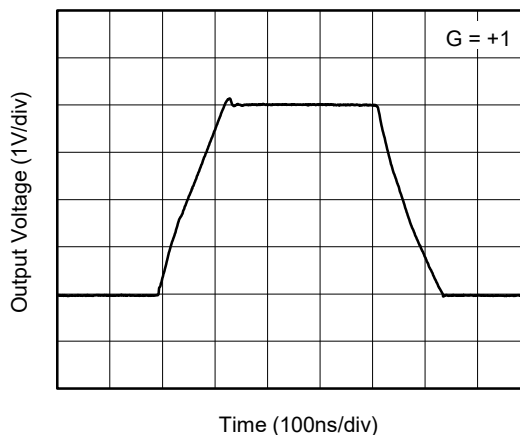
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_L = 10\text{k}\Omega$  and  $C_L = 10\text{pF}$ , unless otherwise noted.

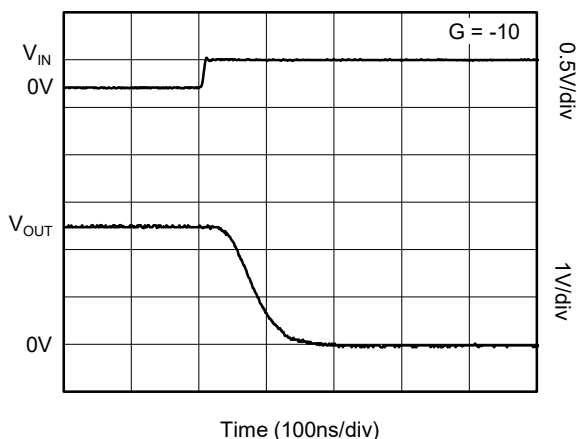
Small-Signal Step Response



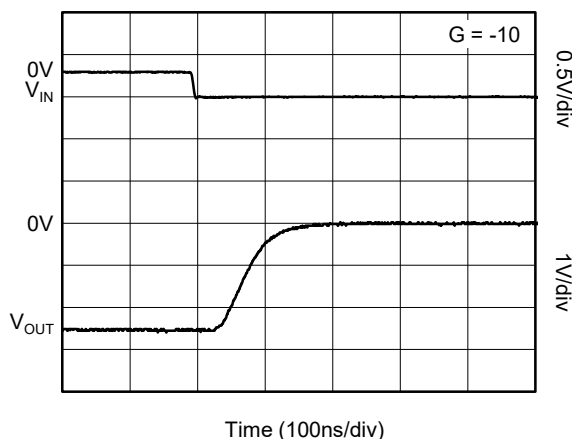
Large-Signal Step Response



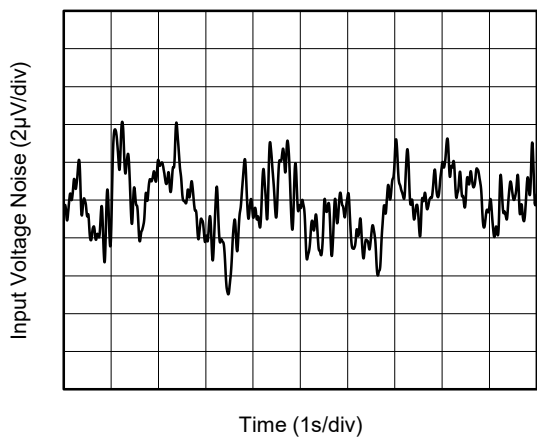
Positive Overload Recovery



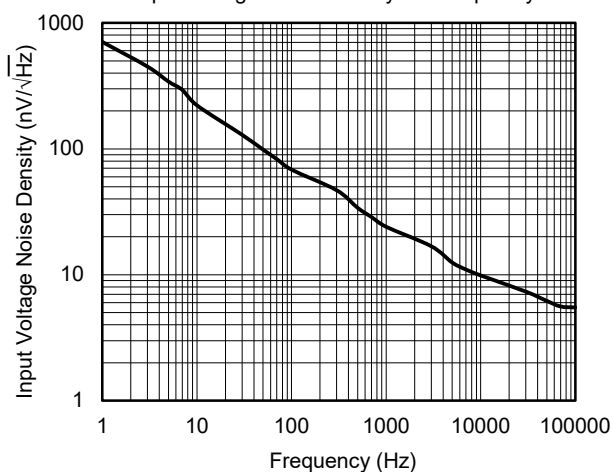
Negative Overload Recovery



0.1Hz to 10Hz Input Voltage Noise

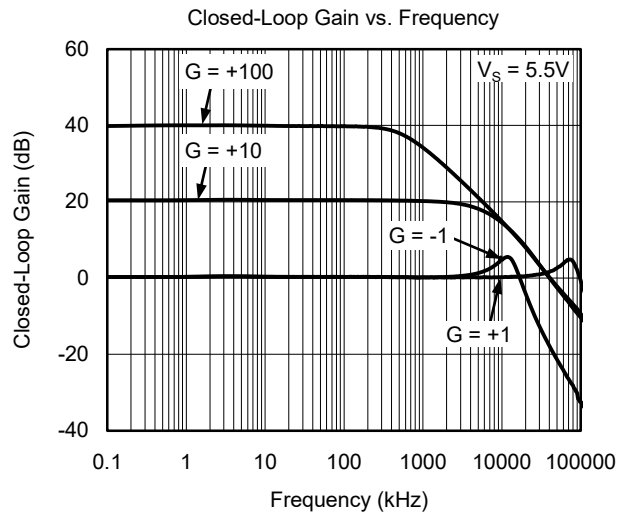
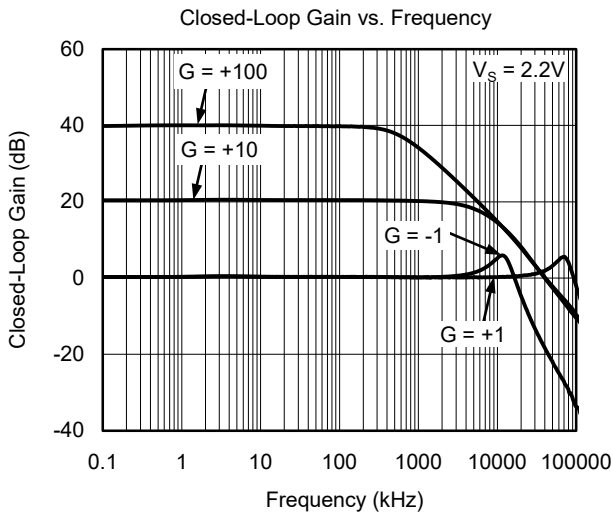
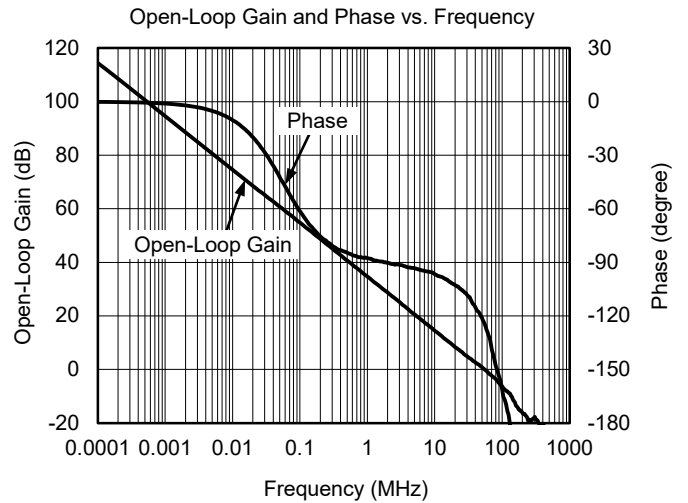
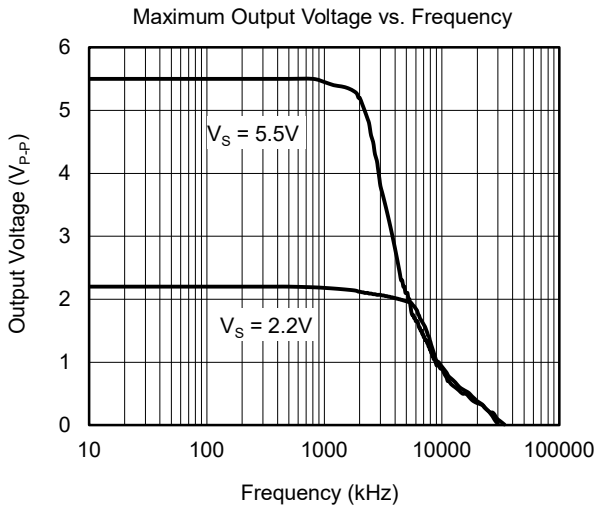
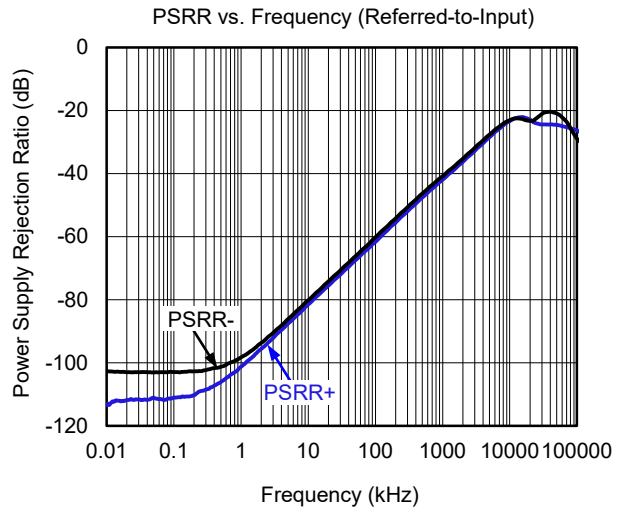
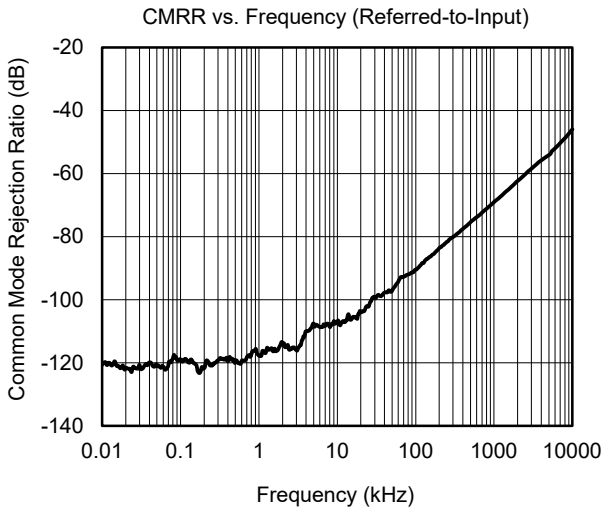


Input Voltage Noise Density vs. Frequency



**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

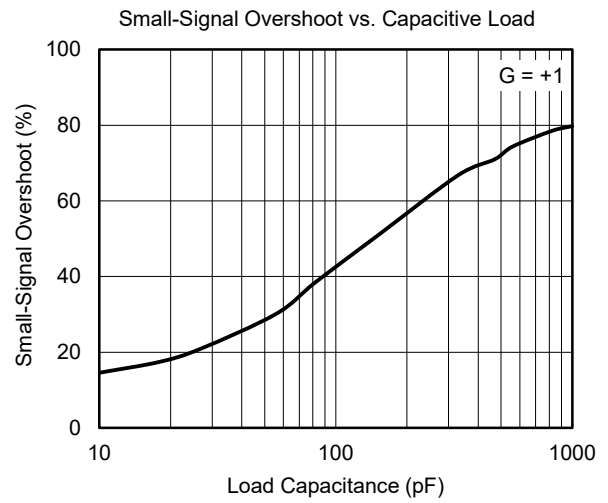
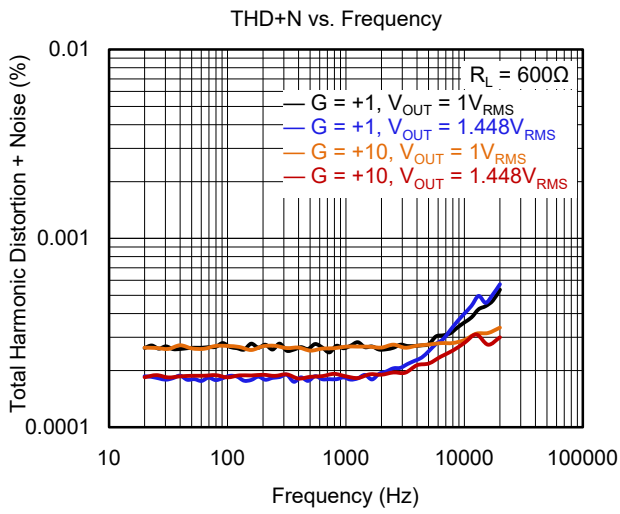
At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_L = 10\text{k}\Omega$  and  $C_L = 10\text{pF}$ , unless otherwise noted.





**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_L = 10\text{k}\Omega$  and  $C_L = 10\text{pF}$ , unless otherwise noted.

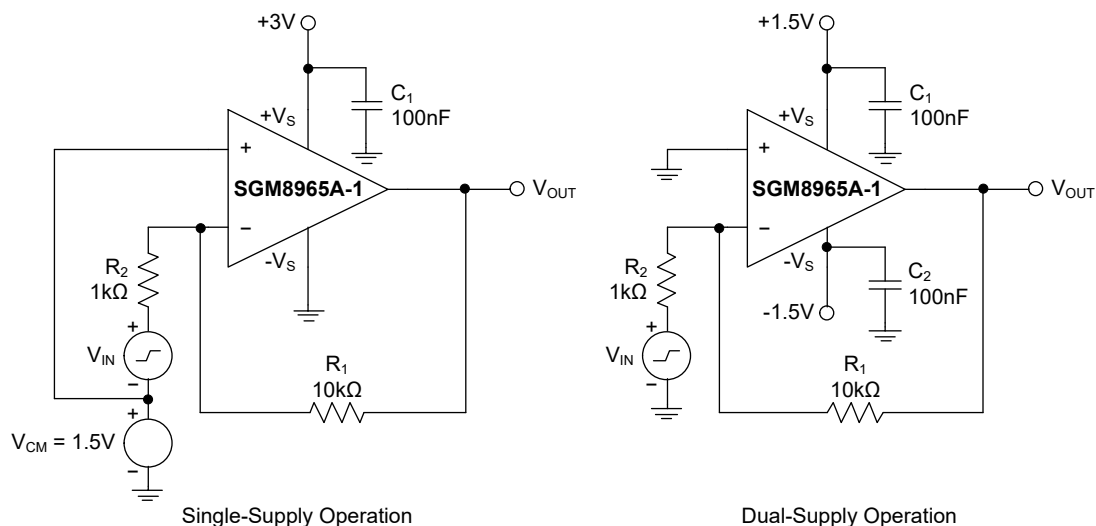


**APPLICATION INFORMATION**

**Basic Connection**

The SGM8965A-1/2 can operate on single supply or dual power supplies, as shown in Figure 1. These devices are designed to be basic inverting amplifiers, whose gain is  $-10V/V$ . For single-supply operation, the output voltage takes input common mode voltage ( $V_{CM}$ )

as the center voltage, which is 1.5V as shown in the following circuit connection. Moreover, the input common mode voltage ( $V_{CM}$ ) is from  $(-V_s) - 0.1V$  to  $(+V_s) + 0.1V$ , and the output voltage can be any value in this range. For dual-supply operation, the output voltage takes 0V as the center voltage.



**Figure 1. Basic Connections**

## **REVISION HISTORY**

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

<b>OCTOBER 2020 – REV.A to REV.A.1</b>	<b>Page</b>
Updated Electrical Characteristics section .....	4

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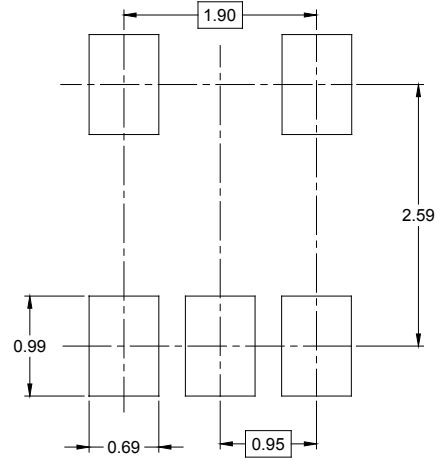
<b>Changes from Original (JULY 2019) to REV.A</b>	<b>Page</b>
Changed from product preview to production data.....	All

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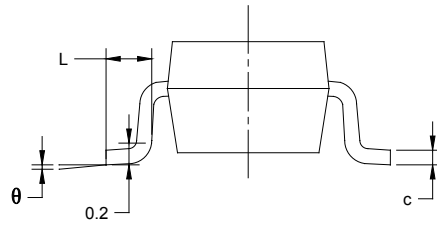
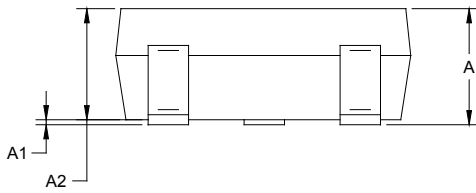
# PACKAGE INFORMATION

## PACKAGE OUTLINE DIMENSIONS

### SOT-23-5



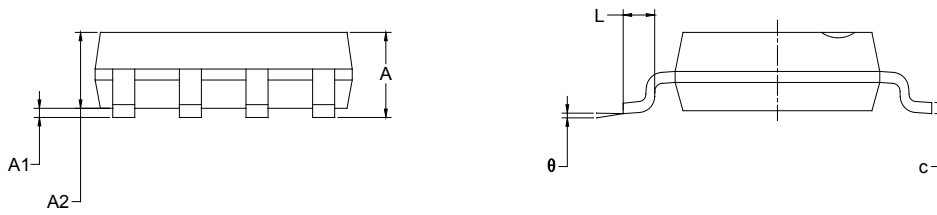
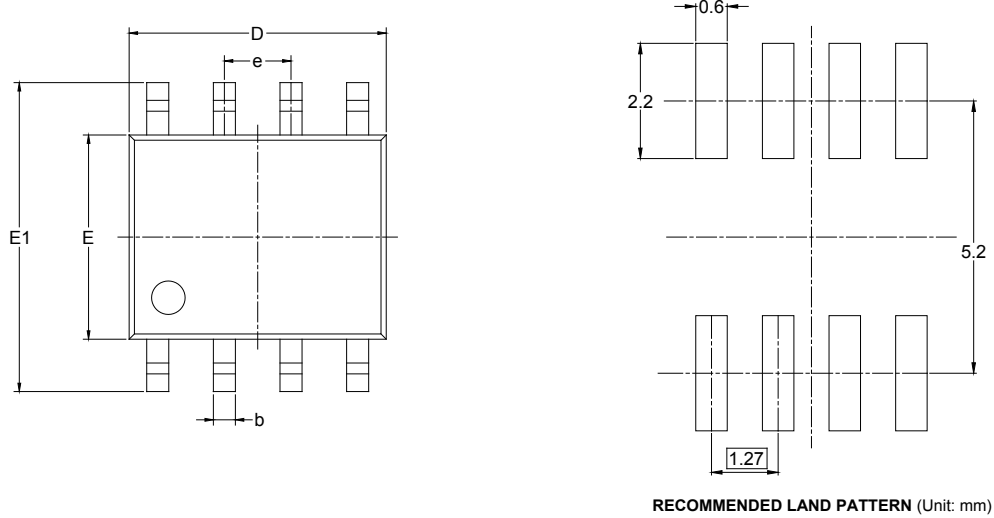
RECOMMENDED LAND PATTERN (Unit: mm)



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

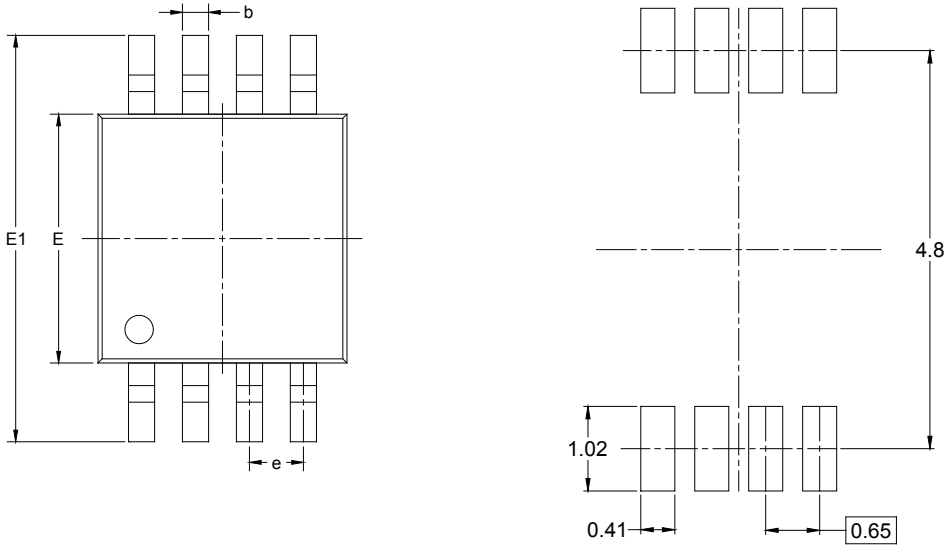
SOIC-8



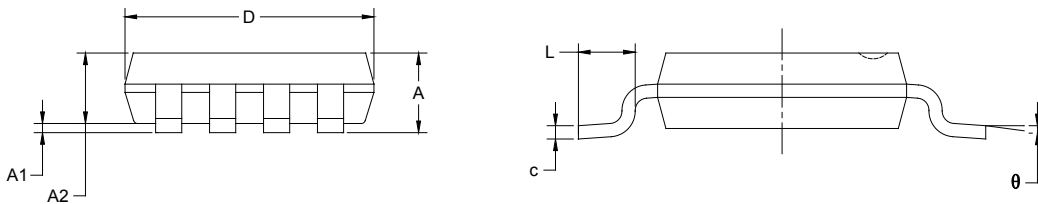
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

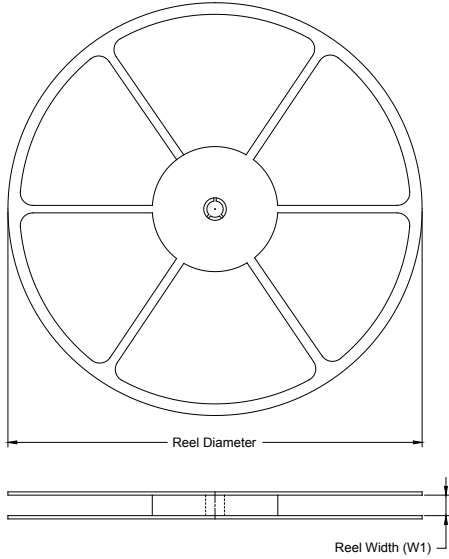


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

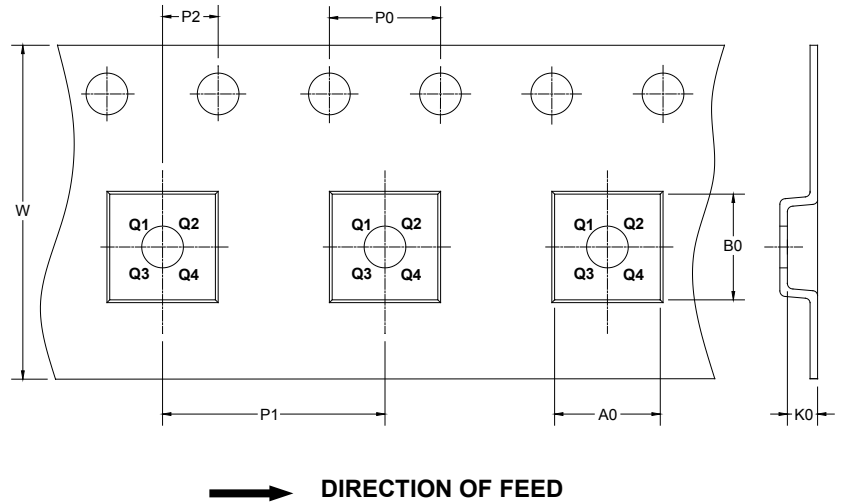
# PACKAGE INFORMATION

## 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
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

# 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

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