



**SGMICRO**

# SGM8607-1 1MHz, High Precision, Rail-to-Rail I/O, Single CMOS Operational Amplifier in WLCSP Package

## GENERAL DESCRIPTION

The SGM8607-1 integrates a single, high precision, low noise, low voltage and low power CMOS operational amplifier in a small, 6-ball WLCSP package. It can operate from 1.8V to 5.5V power supply over the -40°C to +125°C temperature range or operate from 1.7V to 5.5V power supply over the 0°C to +70°C temperature range. The SGM8607-1 supports 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  $(-V_S) + 0.032V$  to  $(+V_S) - 0.05V$  with 600Ω load resistor.

The SGM8607-1 features an input offset voltage of  $\pm 35\mu V$  (MAX), a gain-bandwidth product of 1MHz, and a slew rate of 0.4V/ $\mu s$ .

The SGM8607-1 is available in a Green WLCSP-0.73×1.08-6B package. 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

## FEATURES

- **Low Input Offset Voltage:**  $\pm 35\mu V$  (MAX)
- **Low Input Bias Current:**  $\pm 150pA$  (TYP)
- **Input Voltage Noise Density:**  $30nV/\sqrt{Hz}$  at 10kHz
- **Gain-Bandwidth Product:** 1MHz
- **Gain = +20 Stable for  $C_L = 1nF$   
Unity-Gain Stable for  $C_L = 100pF$**
- **Slew Rate:** 0.4V/ $\mu s$
- **Settling Time to 0.1% with 200mV Step:** 1.2 $\mu s$
- **Overload Recovery Time:** 2 $\mu s$
- **Rail-to-Rail Input and Output**
- **Power Supply Voltage:**
  - ♦ Low 1.8V Supply Rail over the -40°C to +125°C Range
  - ♦ Low 1.7V Supply Rail over the 0°C to +70°C Range
  - ♦ High Supply Voltage: 5.5V
- **Input Signal Range:**  $(-V_S) - 0.1V$  to  $(+V_S) + 0.1V$
- **Low Power:**
  - ♦ 70 $\mu A$  (TYP) Quiescent Current
  - ♦ 0.6 $\mu A$  (MAX) Supply Current in Shutdown
- **Available in a Green WLCSP-0.73×1.08-6B Package**

# 1MHz, High Precision, Rail-to-Rail I/O, Single CMOS Operational Amplifier in WLCSP Package

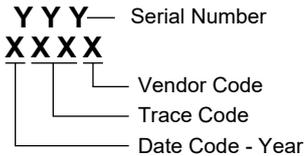
## SGM8607-1

### PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8607-1	WLCSP-0.73×1.08-6B	-40°C to +125°C	SGM8607-1XG/TR	OMI XXXX	Tape and Reel, 3000

### MARKING INFORMATION

NOTE: XXXX = Date Code, Trace 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, +V <sub>S</sub> to -V <sub>S</sub> .....	6.0V
Input Common Mode Voltage Range .....	(-V <sub>S</sub> ) - 0.3V to (+V <sub>S</sub> ) + 0.3V
Package Thermal Resistance	
WLCSP-0.73×1.08-6B, θ <sub>JA</sub> .....	185.4°C/W
WLCSP-0.73×1.08-6B, θ <sub>JB</sub> .....	62.1°C/W
Junction Temperature .....	+150°C
Storage Temperature Range .....	-65°C to +150°C
Lead Temperature (Soldering, 10s) .....	+260°C
ESD Susceptibility <sup>(1) (2)</sup> .....	
HBM .....	±8000V
CDM .....	±1000V

NOTES:

- For human body model (HBM), all pins comply with ANSI/ESDA/JEDEC JS-001 specifications.
- For charged device model (CDM), all pins comply with ANSI/ESDA/JEDEC JS-002 specifications.

### RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range .....	-40°C to +125°C
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### 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.

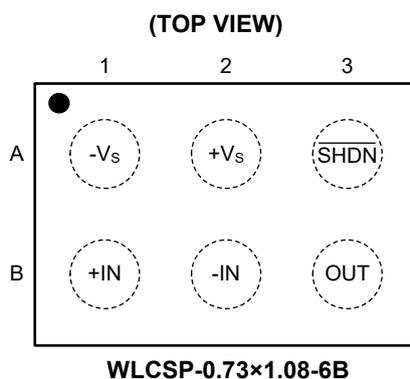
### ESD SENSITIVITY CAUTION

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 CONFIGURATION**



**PIN DESCRIPTION**

PIN	NAME	FUNCTION
A1	-V <sub>S</sub>	Negative Power Supply.
A2	+V <sub>S</sub>	Positive Power Supply. Connect a 0.1μF capacitor to ground for bypassing.
A3	$\overline{\text{SHDN}}$	Active Low Shutdown Mode. When $\overline{\text{SHDN}}$ pin is pulled to -V <sub>S</sub> , the SGM8607-1 is in shutdown status. When $\overline{\text{SHDN}}$ pin is pulled high, the SGM8607-1 is in active status.
B1	+IN	Non-Inverting Input.
B2	-IN	Inverting Input.
B3	OUT	Output.

# SGM8607-1 1MHz, High Precision, Rail-to-Rail I/O, Single CMOS Operational Amplifier in WLCSP Package

## ELECTRICAL CHARACTERISTICS

( $V_S = 3.3V$ ,  $V_{CM} = V_S/2$ ,  $\overline{V_{SHDN}} = +V_S$ , Full =  $-40^\circ C$  to  $+125^\circ C$ , typical values are at  $T_A = +25^\circ C$ , unless otherwise noted.)

PARAMETER	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS	
<b>Input Characteristics</b>							
Input Offset Voltage ( $V_{OS}$ )	$V_S = 5V$	+25°C		±10	±35	μV	
		Full			±70		
Input Offset Voltage Drift ( $\Delta V_{OS}/\Delta T$ )		Full		50	350	nV/°C	
Input Bias Current ( $I_B$ )	$V_S = 1.8V$ to $5.5V$	+25°C		±150	±650	pA	
		Full			±5	nA	
Input Offset Current ( $I_{OS}$ )	$V_S = 1.8V$ to $5.5V$	+25°C		±300		pA	
Input Common Mode Voltage Range ( $V_{CM}$ )		Full	$(-V_S) - 0.1$		$(+V_S) + 0.1$	V	
Common Mode Rejection Ratio (CMRR)	$(-V_S) - 0.1V \leq V_{CM} \leq (+V_S) + 0.1V$	+25°C	97	114		dB	
		Full	94				
Open-Loop Voltage Gain ( $A_{OL}$ )	$(-V_S) + 0.25V < V_{OUT} < (+V_S) - 0.25V$ , $R_L = 600\Omega$	+25°C	102	120		dB	
		Full	99				
	$(-V_S) + 0.1V < V_{OUT} < (+V_S) - 0.1V$ , $R_L = 10k\Omega$	+25°C	102	120			
		Full	99				
Input Capacitance ( $C_{IN}$ )		+25°C		28		pF	
<b>Output Characteristics</b>							
Output Voltage Low	$V_{OL} = V_{OUT} - (-V_S)$	$R_L = 600\Omega$	+25°C		32	50	mV
			Full			70	
		$R_L = 10k\Omega$	+25°C		2	5	
			Full			7	
Output Voltage High	$V_{OH} = (+V_S) - V_{OUT}$	$R_L = 600\Omega$	+25°C		50	65	mV
			Full			92	
		$R_L = 10k\Omega$	+25°C		3	7	
			Full			9	
Output Short-Current Limited ( $I_{LIM}$ )	Short to $+V_S$ or $-V_S$	+25°C		±28		mA	
<b>Power Supply</b>							
Operating Voltage Range ( $V_S$ )		Full	1.8		5.5	V	
		0°C to +70°C	1.7		5.5		
Power Supply Rejection Ratio (PSRR)	$V_S = 1.8V$ to $5.5V$ , $V_{CM} = (-V_S) + 0.5V$	+25°C	100	115		dB	
		Full	97				
Quiescent Current ( $I_Q$ )	$I_{OUT} = 0A$	+25°C		70	100	μA	
		Full			120		
Shutdown Supply Current ( $\overline{I_{SHDN}}$ )	$I_{OUT} = 0A$ , $\overline{V_{SHDN}} = -V_S$	+25°C			0.6	μA	

# 1MHz, High Precision, Rail-to-Rail I/O, Single SGM8607-1 CMOS Operational Amplifier in WLCSP Package

## ELECTRICAL CHARACTERISTICS (continued)

( $V_S = 3.3V$ ,  $V_{CM} = V_S/2$ ,  $V_{SHDN} = +V_S$ , Full =  $-40^\circ C$  to  $+125^\circ C$ , typical values are at  $T_A = +25^\circ C$ , unless otherwise noted.)

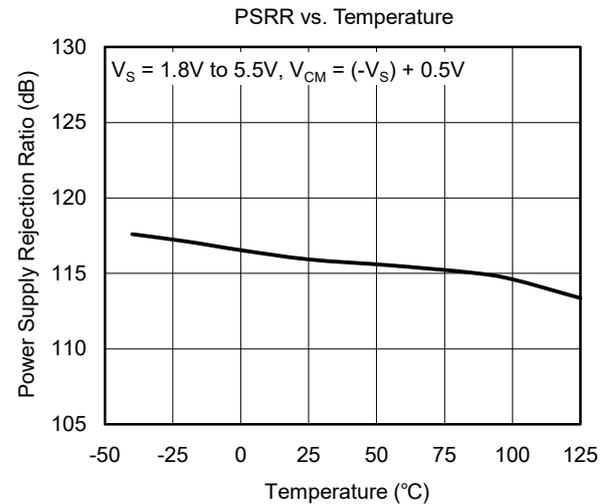
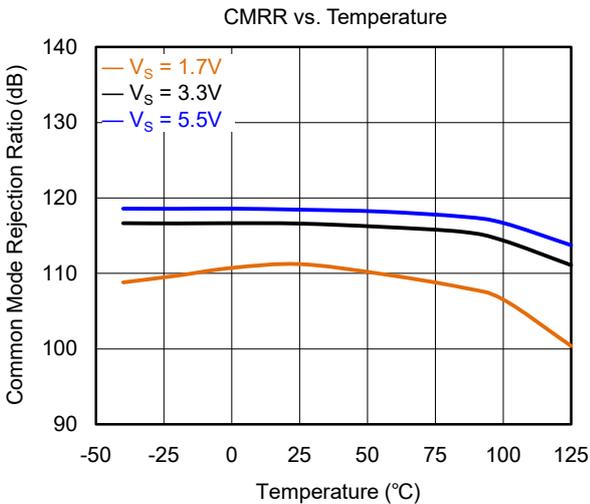
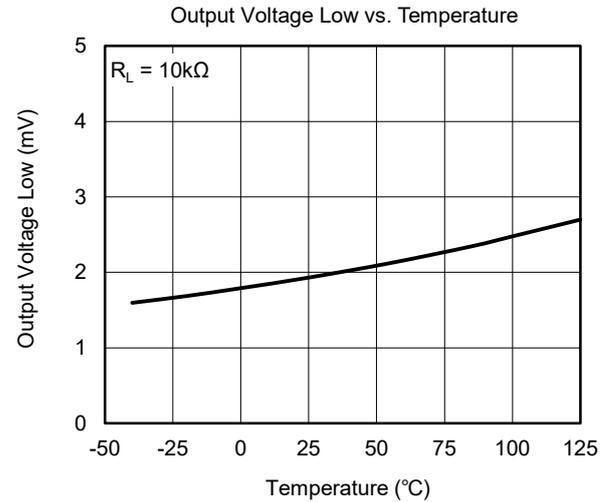
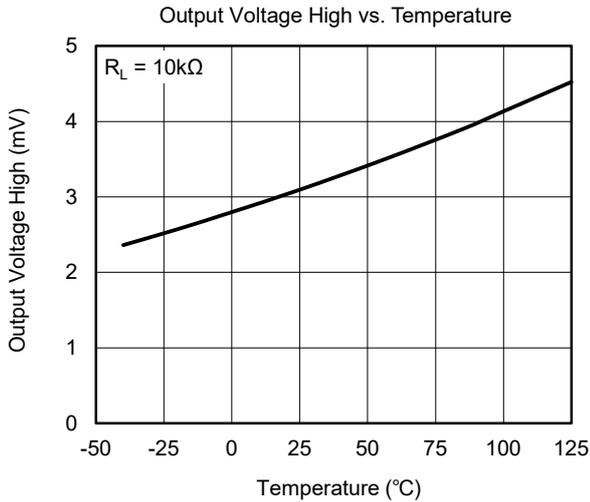
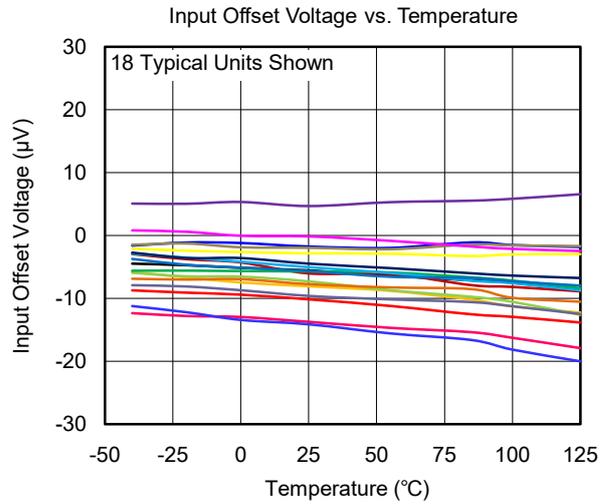
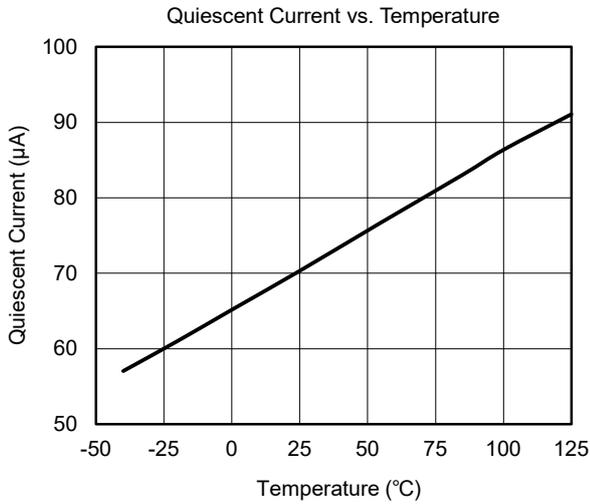
PARAMETER	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
<b>Dynamic Performance</b>						
Gain-Bandwidth Product (GBP) <sup>(1)</sup>		+25°C	0.3	1	2	MHz
Phase Margin ( $\phi_o$ )	G = +20, $R_L = 10k\Omega$ , $C_L = 1nF$	+25°C		60		°
	G = +1, $R_L = 10k\Omega$ , $C_L = 100pF$	+25°C		55		
Slew Rate (SR)	G = +1, 2V output step	+25°C		0.4		V/ $\mu s$
Settling Time to 0.1% ( $t_s$ )	G = +1, 200mV output step	+25°C		1.2		$\mu s$
Overload Recovery Time (ORT)	$V_{IN} \times G = V_S$	+25°C		2		$\mu s$
<b>Noise Performance</b>						
Input Voltage Noise	f = 0.1Hz to 10Hz	+25°C		0.6		$\mu V_{P-P}$
Input Voltage Noise Density ( $e_n$ ) <sup>(1)</sup>	f = 10kHz	Full		30	46	nV/ $\sqrt{Hz}$
<b>EN Control</b>						
Input Voltage Low ( $V_{IL}$ )	+ $V_S = 1.8V$ to 5.5V, - $V_S = GND$	Full			0.4	V
Input Voltage High ( $V_{IH}$ )	+ $V_S = 1.8V$ to 5.5V, - $V_S = GND$	Full	1.7			V
Turn-On Time from Shutdown ( $t_{SHDN}$ )		+25°C		400	650	$\mu s$
		Full			850	
Power-Up Time ( $t_{ON}$ ) <sup>(1)</sup>		Full		0.7	1.4	ms

NOTE: 1. Limits are specified by design and characterization, not production tested.

# SGM8607-1 1MHz, High Precision, Rail-to-Rail I/O, Single CMOS Operational Amplifier in WLCSP Package

## TYPICAL PERFORMANCE CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 3.3\text{V}$ ,  $V_{CM} = V_S/2$ ,  $V_{SHDN} = +V_S$ , unless otherwise noted.

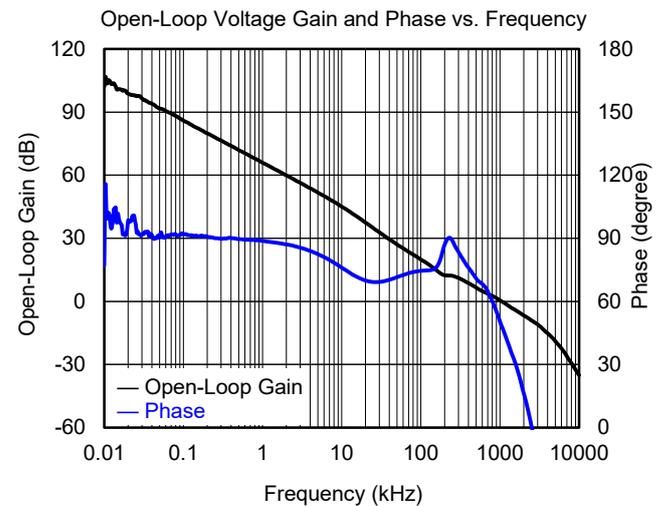
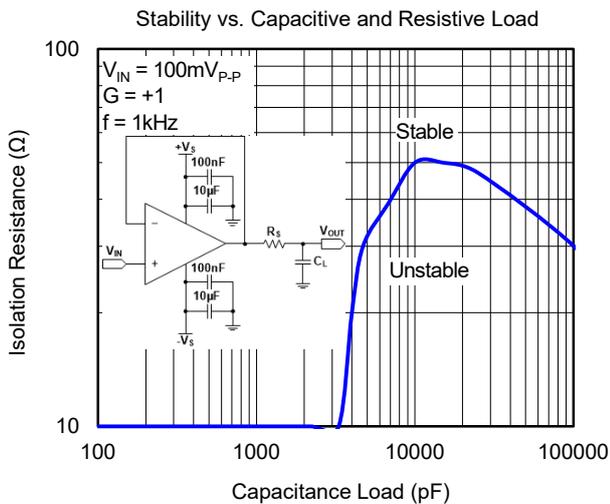
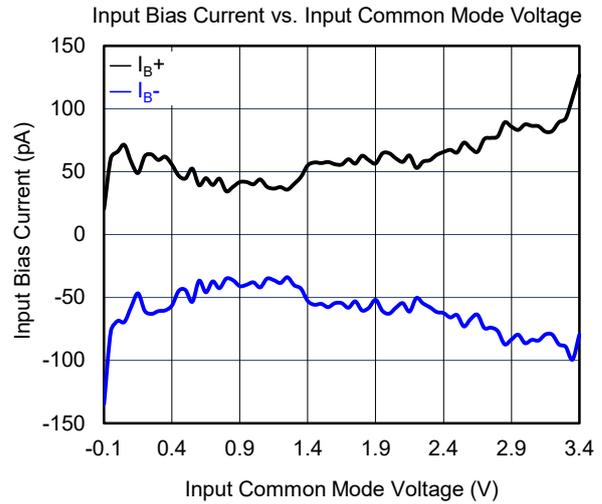
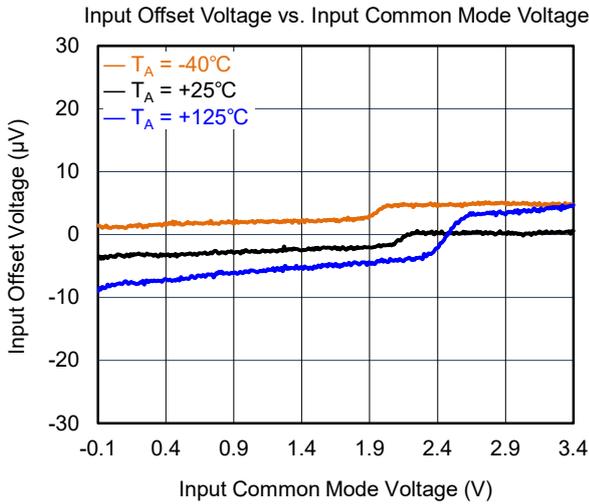
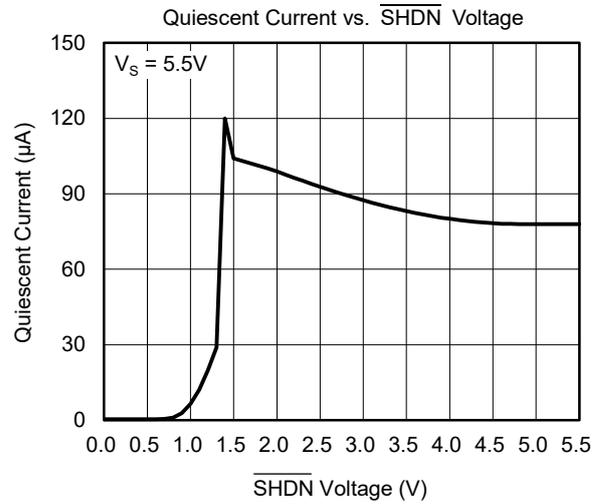
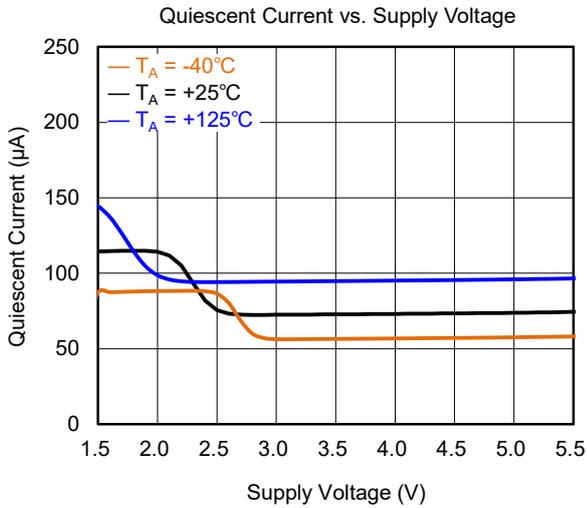


# SGM8607-1

## 1MHz, High Precision, Rail-to-Rail I/O, Single CMOS Operational Amplifier in WLCSP Package

### TYPICAL PERFORMANCE CHARACTERISTICS (continued)

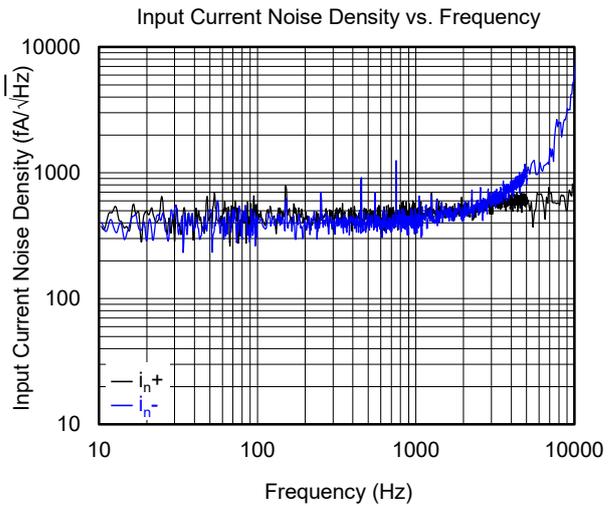
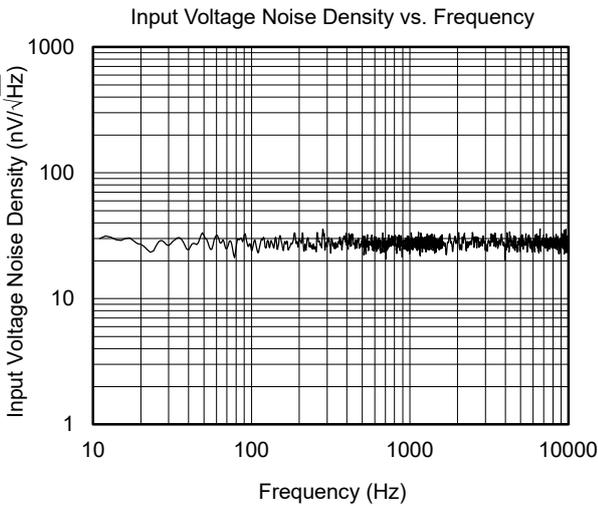
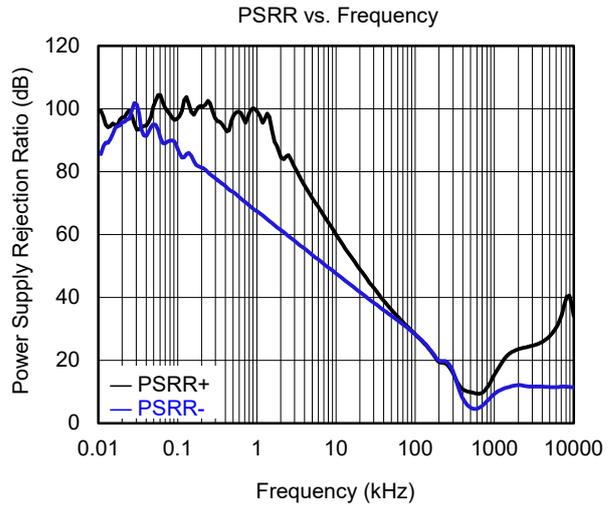
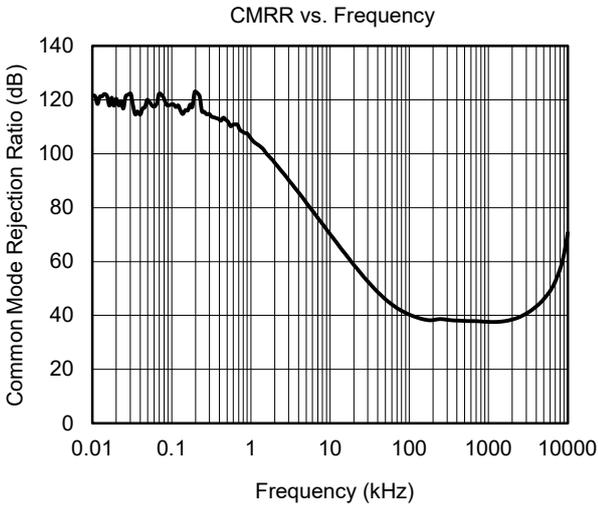
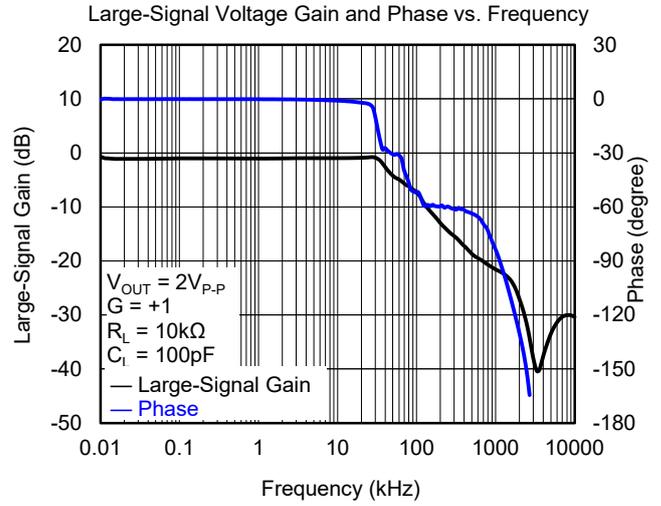
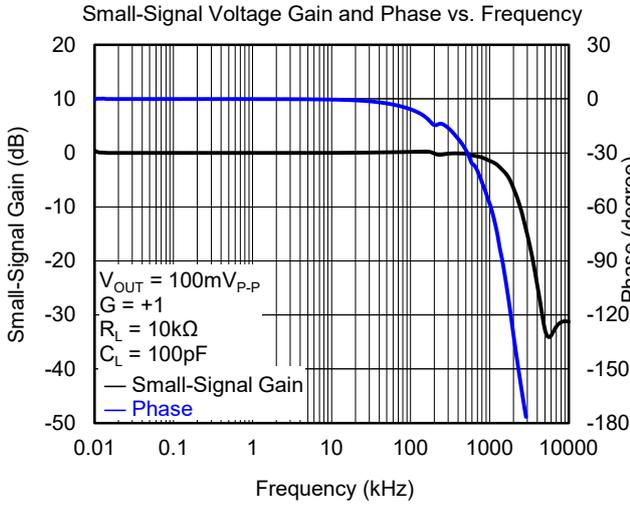
At  $T_A = +25^\circ\text{C}$ ,  $V_S = 3.3\text{V}$ ,  $V_{CM} = V_S/2$ ,  $V_{SHDN} = +V_S$ , unless otherwise noted.



# SGM8607-1 1MHz, High Precision, Rail-to-Rail I/O, Single CMOS Operational Amplifier in WLCSP Package

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 3.3\text{V}$ ,  $V_{CM} = V_S/2$ ,  $V_{SHDN} = +V_S$ , unless otherwise noted.

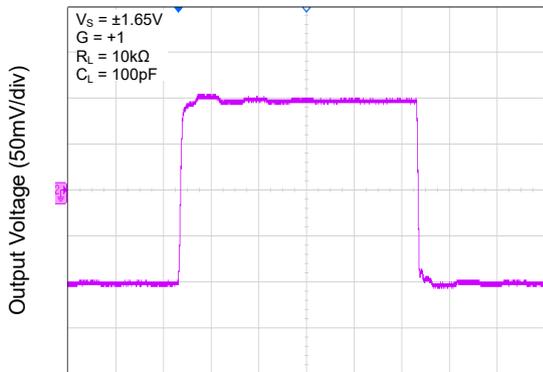


# SGM8607-1 1MHz, High Precision, Rail-to-Rail I/O, Single CMOS Operational Amplifier in WLCSP Package

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

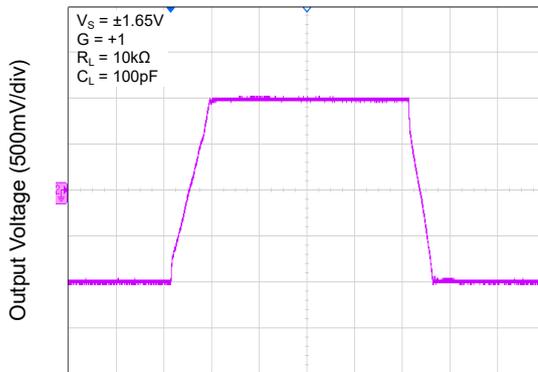
At  $T_A = +25^\circ\text{C}$ ,  $V_S = 3.3\text{V}$ ,  $V_{CM} = V_S/2$ ,  $V_{SHDN} = +V_S$ , unless otherwise noted.

Small-Signal Step Response



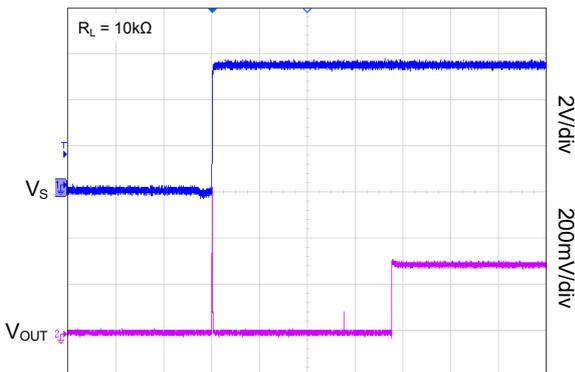
Time (5µs/div)

Large-Signal Step Response



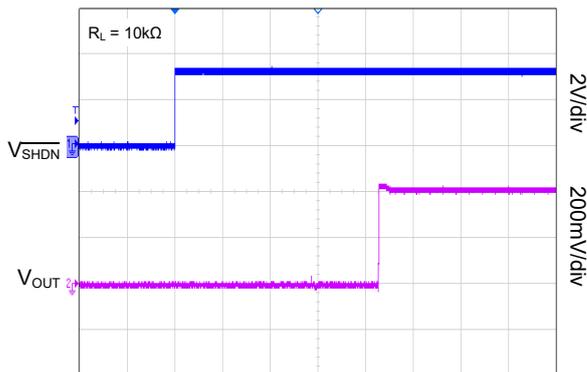
Time (5µs/div)

Power-Up Time



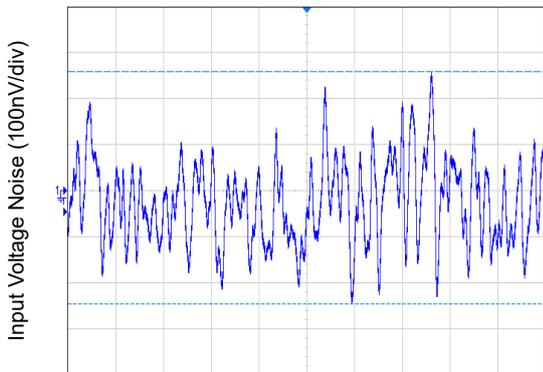
Time (200µs/div)

Shutdown Enable Response



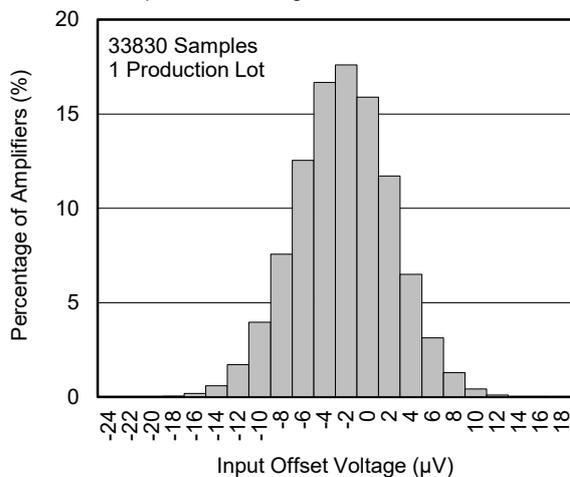
Time (100µs/div)

0.1Hz to 10Hz Input Voltage Noise



Time (500ms/div)

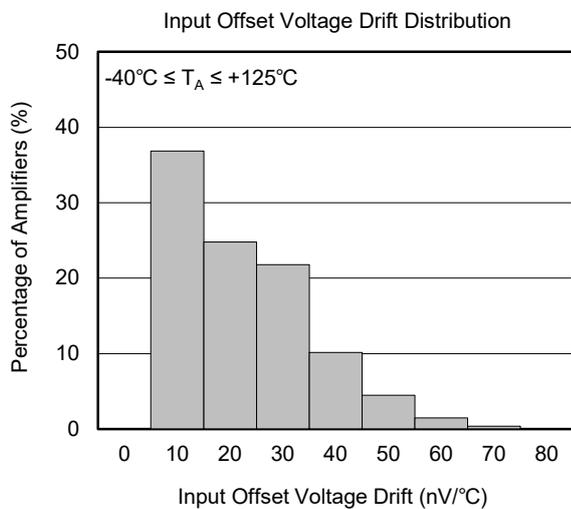
Input Offset Voltage Production Distribution



# SGM8607-1 1MHz, High Precision, Rail-to-Rail I/O, Single CMOS Operational Amplifier in WLCSP Package

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 3.3\text{V}$ ,  $V_{\text{CM}} = V_S/2$ ,  $V_{\text{SHDN}} = +V_S$ , unless otherwise noted.



APPLICATION INFORMATION

Rail-to-Rail Input

The input common mode voltage range of the SGM8607-1 extends 100mV beyond the supply rails for the full supply voltage range. In Figure 1, the ESD diodes between the inputs and the power supply rails will clamp the input voltage so that it does not exceed the rails.

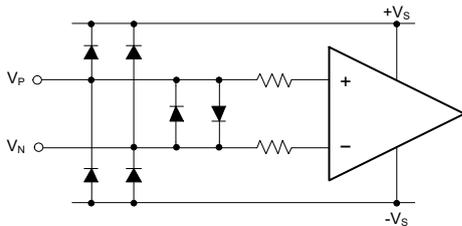


Figure 1. Input Equivalent Circuit

Rail-to-Rail Output

The SGM8607-1 supports rail-to-rail output operation. In single power supply application, for example, when  $+V_S = 3.3V$ ,  $-V_S = GND$ , 600Ω load resistor is tied from OUT pin to ground, the typical output swing range is from 0.032V to 3.25V.

Driving Capacitive Loads

The SGM8607-1 can directly drive a 1nF capacitor at Gain = +20 or a 100pF capacitor at Gain = +1 without oscillation. If greater capacitive load must be driven in application, the circuit in Figure 2 can be used. In this circuit, the IR drop voltage generated by  $R_{ISO}$  is compensated by feedback loop.

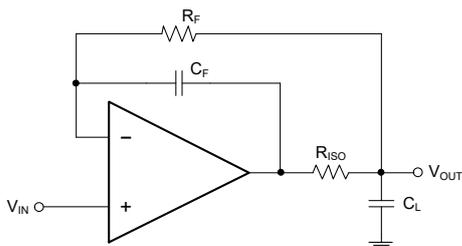


Figure 2. Circuit to Drive Heavy Capacitive Load

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 amplifier 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 3. The ceramic capacitors should be placed as close as possible to  $+V_S$  and  $-V_S$  power supply pins.

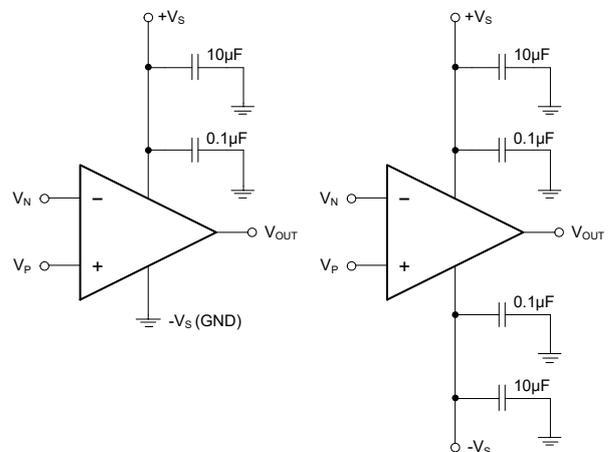


Figure 3. Amplifier Power Supply Bypassing

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 the 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.

APPLICATION INFORMATION (continued)

Typical Application Circuits

Difference Amplifier

The circuit in Figure 4 is a design example of classical difference amplifier. If  $R_4/R_3 = R_2/R_1$ , then  $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$ .

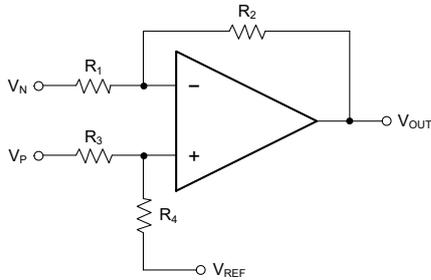


Figure 4. Difference Amplifier

High Input Impedance Difference Amplifier

The circuit in Figure 5 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 4.

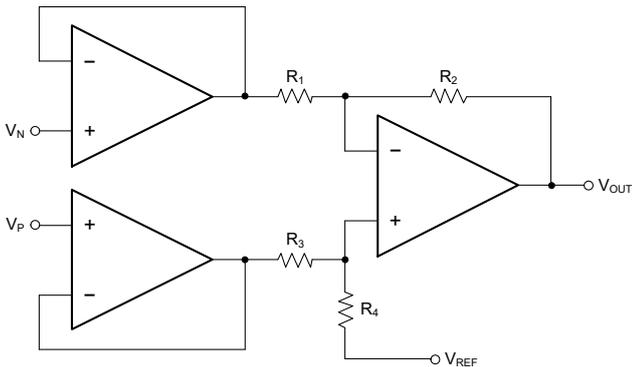


Figure 5. High Input Impedance Difference Amplifier

Active Low-Pass Filter

The circuit in Figure 6 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  $1/(2\pi R_2 C)$ . 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.

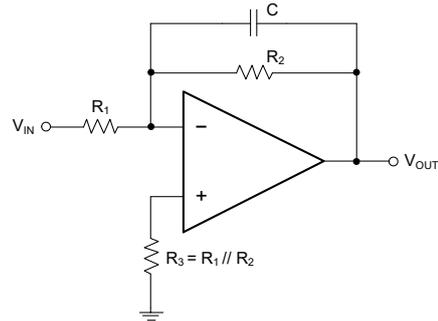


Figure 6. Active Low-Pass Filter

**REVISION HISTORY**

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

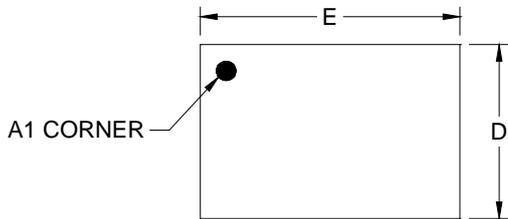
<b>Changes from Original to REV.A (JUNE 2025)</b>	<b>Page</b>
Changed from product preview to production data.....	All

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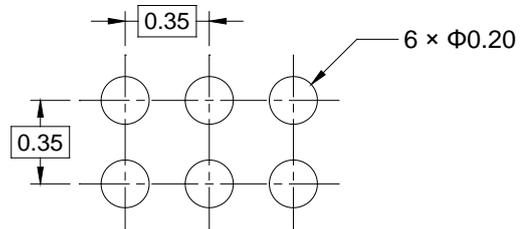
# PACKAGE INFORMATION

## PACKAGE OUTLINE DIMENSIONS

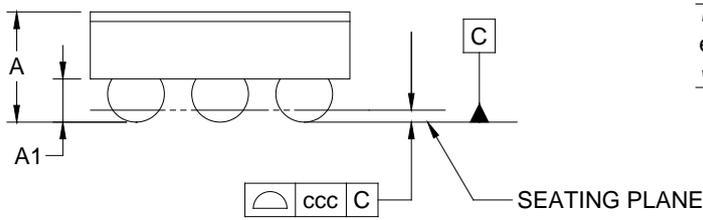
### WLCSP-0.73x1.08-6B



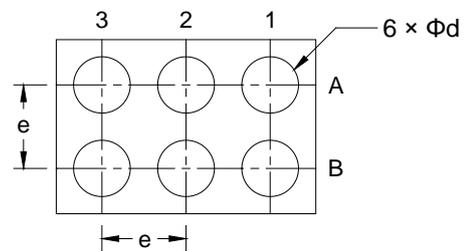
TOP VIEW



RECOMMENDED LAND PATTERN (Unit: mm)



SIDE VIEW



BOTTOM VIEW

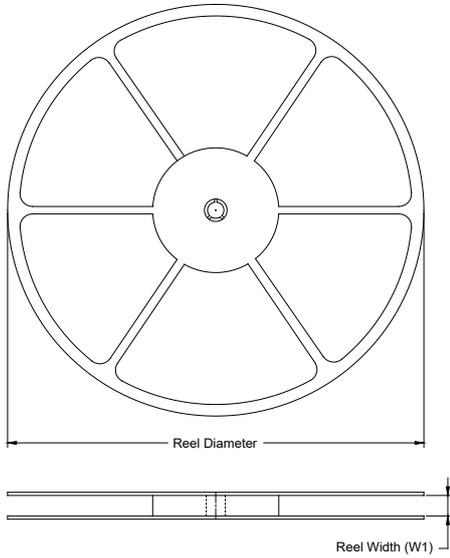
Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	-	-	0.500
A1	0.161	-	0.201
D	0.697	-	0.757
E	1.047	-	1.107
d	0.206	-	0.266
e	0.350 BSC		
ccc	0.050		

NOTE: This drawing is subject to change without notice.

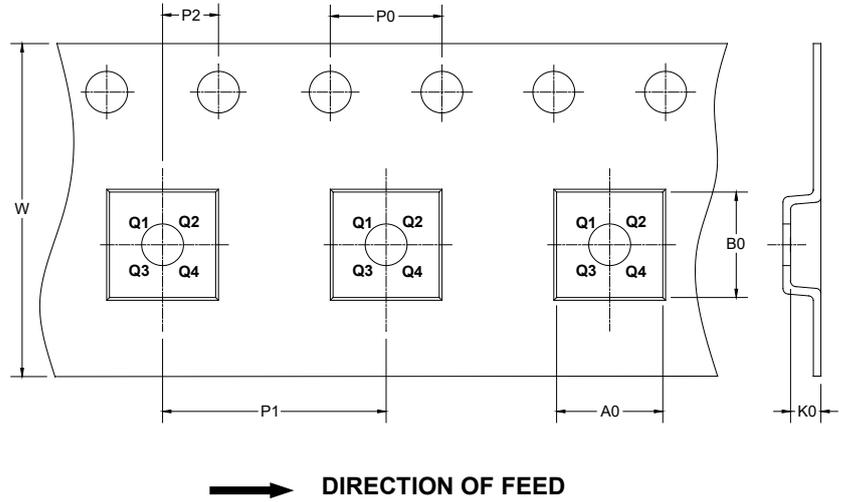
# PACKAGE INFORMATION

## TAPE AND REEL INFORMATION

### REEL DIMENSIONS



### TAPE DIMENSIONS



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

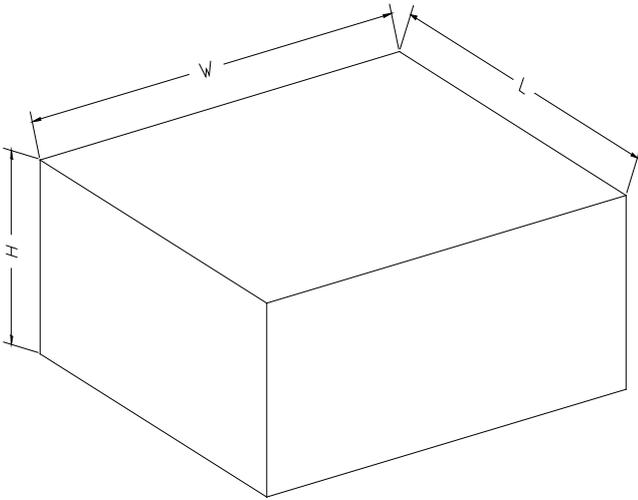
### KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
WLCSP-0.73×1.08-6B	7"	9.2	0.81	1.17	0.57	4.0	4.0	2.0	8.0	Q2

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# 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

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