

## GENERAL DESCRIPTION

The SGM2904 is a dual operational amplifier which is designed to offer a wide input common mode voltage range and output voltage swing. The device can operate from  $\pm 1.65\text{V}$  to  $\pm 13\text{V}$  dual power supplies or from 3.3V to 26V single supply.

The device features low noise, high slew rate, low input bias and offset current, and low offset voltage.

The SGM2904 is available in Green SOIC-8 and MSOP-8 packages. It is specified over the extended  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  temperature range.

## FEATURES

- **Wide Input Common Mode and Differential Voltage Ranges**
- **Low Input Bias and Offset Current**
- **Output Short-Circuit Protection**
- **High Input Impedance**
- **Low Offset Voltage: 4mV (MAX)**
- **Low Noise:  $40\text{nV}/\sqrt{\text{Hz}}$  at 1kHz**
- **Gain-Bandwidth Product: 2MHz**
- **Slew Rate:  $0.6\text{V}/\mu\text{s}$**
- **$-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  Operating Temperature Range**
- **Available in Green SOIC-8 and MSOP-8 Packages**

## APPLICATIONS

High Impedance Sensor  
Photodiode Amplifier  
High End, Professional Audio  
DAC Output Amplifier  
Medical

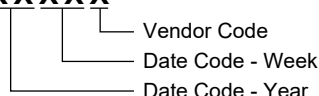
## PACKAGE/ORDERING INFORMATION

| MODEL   | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING          | PACKING OPTION      |
|---------|---------------------|-----------------------------|-----------------|--------------------------|---------------------|
| SGM2904 | SOIC-8              | -40°C to +125°C             | SGM2904XS8G/TR  | SGM<br>2904XS8<br>XXXXX  | Tape and Reel, 4000 |
|         | MSOP-8              | -40°C to +125°C             | SGM2904XMS8G/TR | SGM2904<br>XMS8<br>XXXXX | Tape and Reel, 4000 |

## MARKING INFORMATION

NOTE: XXXXX = Date Code and Vendor Code.

XXXXX



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  $-V_S$ .....26V  
 Input/Output Voltage Range.....( $-V_S$ ) - 0.3V to ( $+V_S$ ) + 0.3V  
 Junction Temperature.....+150°C  
 Storage Temperature Range.....-65°C to +150°C  
 Lead Temperature (Soldering, 10s).....+260°C  
 ESD Susceptibility  
 HBM.....6000V  
 MM.....400V  
 CDM.....2000V

## RECOMMENDED OPERATING CONDITIONS

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

NOTE:

1. Proper power supply sequencing is recommended for the CMOS device. Always sequence  $V_S$  on first, followed by the inputs and outputs.

## 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.

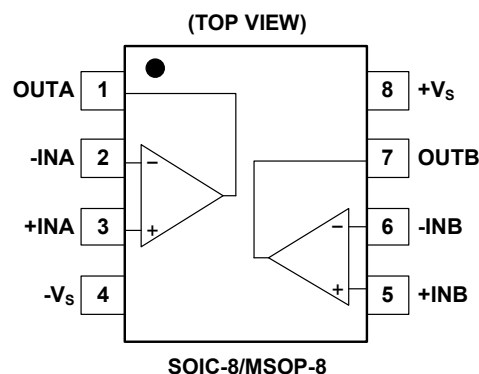
## ESD SENSITIVITY CAUTION

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



## ELECTRICAL CHARACTERISTICS

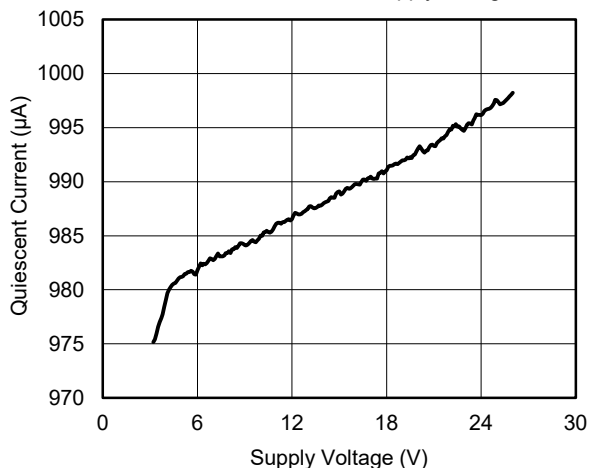
(At  $T_A = +25^\circ\text{C}$ ,  $V_S = 3.3\text{V}$  to  $26\text{V}$  and  $R_L = 2\text{k}\Omega$  connected to  $V_S/2$ , Full =  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted.)

| PARAMETER                             | SYMBOL               | CONDITIONS                                                               | TEMP  | MIN | TYP | MAX                  | UNITS  |
|---------------------------------------|----------------------|--------------------------------------------------------------------------|-------|-----|-----|----------------------|--------|
| Input Characteristics                 |                      |                                                                          |       |     |     |                      |        |
| Input Offset Voltage                  | V <sub>OS</sub>      | V <sub>CM</sub> = V <sub>S</sub> /2                                      | +25°C |     | 3   | 4                    | mV     |
|                                       |                      |                                                                          | Full  |     |     | 5                    |        |
| Input Offset Voltage Drift            | ΔV <sub>OS</sub> /ΔT |                                                                          | Full  |     | 2   |                      | μV/°C  |
| Input Bias Current                    | I <sub>B</sub>       | V <sub>CM</sub> = V <sub>S</sub> /2                                      | +25°C |     | 20  |                      | nA     |
| Input Offset Current                  | I <sub>OS</sub>      | V <sub>CM</sub> = V <sub>S</sub> /2                                      | +25°C |     | 2   |                      | nA     |
| Maximum Differential Input Voltage    | IV <sub>ID</sub> I   |                                                                          | Full  |     |     | V <sub>S</sub>       | V      |
| Maximum Input Difference Bias Current | II <sub>ID</sub> I   | V <sub>ID</sub> = 26V                                                    | +25°C |     | 2   | 3                    | μA     |
|                                       |                      |                                                                          | Full  |     |     | 4                    |        |
| Input Common Mode Voltage Range       | V <sub>CM</sub>      |                                                                          | Full  | 0   |     | V <sub>S</sub> - 1.5 | V      |
| Common Mode Rejection Ratio           | CMRR                 | V <sub>S</sub> = 5V to 26V, 0V < V <sub>CM</sub> < V <sub>S</sub> - 1.5V | +25°C | 70  | 80  |                      | dB     |
|                                       |                      |                                                                          | Full  | 65  |     |                      |        |
| Open-Loop Voltage Gain                | A <sub>OL</sub>      | V <sub>S</sub> = 15V, V <sub>OUT</sub> = 1V to 11V                       | +25°C | 30  | 100 |                      | V/mV   |
|                                       |                      |                                                                          | Full  | 20  |     |                      |        |
| Output Characteristics                |                      |                                                                          |       |     |     |                      |        |
| High-Level Output Voltage             | V <sub>OH</sub>      | V <sub>S</sub> = 26V, R <sub>L</sub> = 10kΩ                              | +25°C |     | 60  | 80                   | mV     |
|                                       |                      |                                                                          | Full  |     |     | 120                  |        |
|                                       |                      | V <sub>S</sub> = 26V, R <sub>L</sub> = 2kΩ                               | +25°C |     | 300 | 400                  |        |
|                                       |                      |                                                                          | Full  |     |     | 540                  |        |
| Low-Level Output Voltage              | V <sub>OL</sub>      | V <sub>S</sub> = 26V, R <sub>L</sub> = 10kΩ                              | +25°C |     | 20  | 35                   | mV     |
|                                       |                      |                                                                          | Full  |     |     | 60                   |        |
|                                       |                      | V <sub>S</sub> = 26V, R <sub>L</sub> = 2kΩ                               | +25°C |     | 110 | 160                  |        |
|                                       |                      |                                                                          | Full  |     |     | 280                  |        |
| Output Short-Circuit Current          | I <sub>SC</sub>      | V <sub>S</sub> = 5V to 26V                                               | +25°C | ±28 | ±40 |                      | mA     |
| Power Supply                          |                      |                                                                          |       |     |     |                      |        |
| Operating Voltage Range               | V <sub>S</sub>       |                                                                          | Full  | 3.3 |     | 26                   | V      |
| Quiescent Current                     | I <sub>Q</sub>       | I <sub>OUT</sub> = 0                                                     | +25°C |     | 1   | 1.24                 | mA     |
|                                       |                      |                                                                          | Full  |     |     | 1.5                  |        |
| Power Supply Rejection Ratio          | PSRR                 | V <sub>S</sub> = 5V to 26V                                               | +25°C | 90  | 100 |                      | dB     |
|                                       |                      |                                                                          | Full  | 85  |     |                      |        |
| Dynamic Performance                   |                      |                                                                          |       |     |     |                      |        |
| Gain-Bandwidth Product                | GBP                  | C <sub>L</sub> = 50pF                                                    | +25°C |     | 2   |                      | MHz    |
| Slew Rate                             | SR                   | A <sub>V</sub> = +1                                                      | +25°C |     | 0.6 |                      | V/μs   |
| Input Voltage Noise Density           | e <sub>n</sub>       | f = 1kHz                                                                 | +25°C |     | 40  |                      | nV/√Hz |

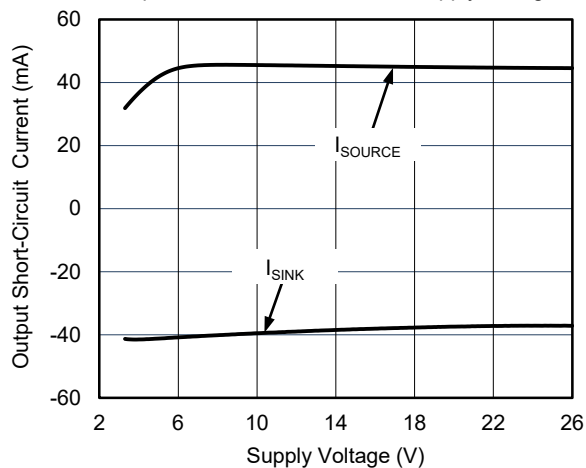
## TYPICAL PERFORMANCE CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 26\text{V}$  and  $R_L = 2\text{k}\Omega$ , unless otherwise noted.

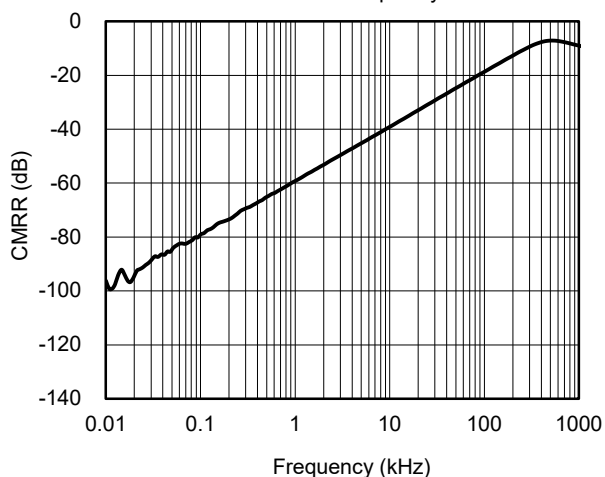
Quiescent Current vs. Supply Voltage



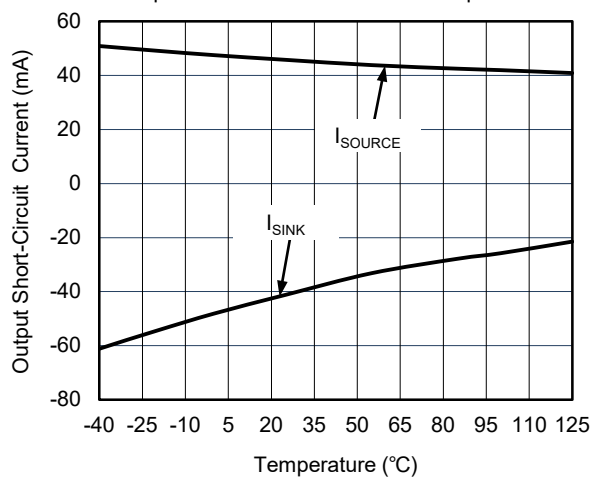
Output Short-Circuit Current vs. Supply Voltage



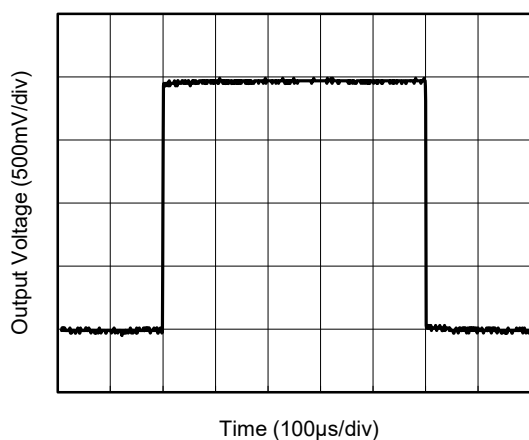
CMRR vs. Frequency



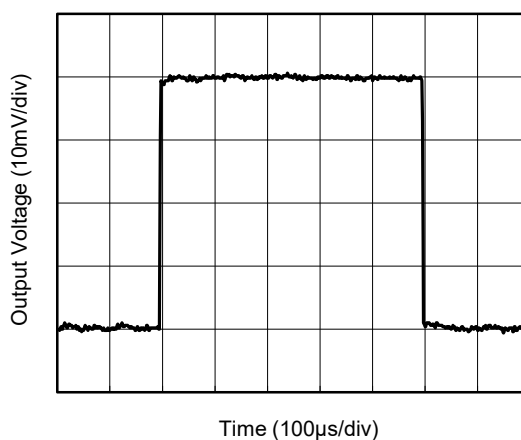
Output Short-Circuit Current vs. Temperature



Large-Signal Step Response



Small-Signal Step Response



## APPLICATION INFORMATION

The SGM2904 operational amplifier is useful in a wide range of signal conditioning applications.

### Typical Application

A typical application for an operational amplifier is an inverting amplifier. This amplifier takes a positive voltage on the input and makes it a negative voltage of the same magnitude. In the same manner, it also makes negative voltages positive.

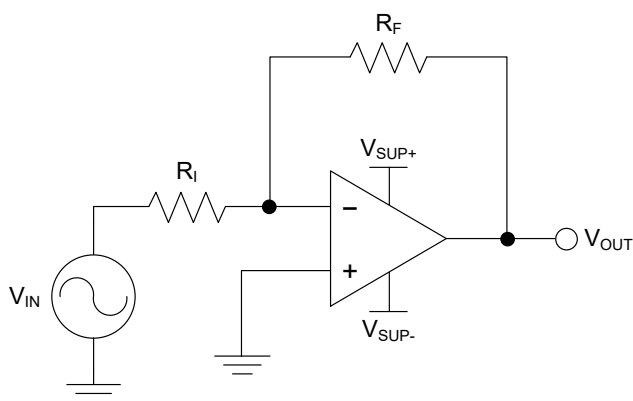


Figure 1. Application Schematic

The supply voltage must be chosen such that it is larger than the input voltage range and output range. For instance, this application will scale a signal of  $\pm 0.5\text{V}$  to  $\pm 1.8\text{V}$ . Setting the supply at  $\pm 12\text{V}$  is sufficient to accommodate this application.

Determine the gain required by the inverting amplifier using Equation 1 and Equation 2:

$$A_V = \frac{V_{OUT}}{V_{IN}} \quad (1)$$

$$A_V = \frac{1.8}{-0.5} = -3.6 \quad (2)$$

Once the desired gain is determined, choose a value for  $R_I$  or  $R_F$ . Choosing a value in the  $\text{k}\Omega$  range is desirable because the amplifier circuit will use currents in the milliamp range. This ensures the part will not draw too much current. This example will choose  $10\text{k}\Omega$  for  $R_I$  which means  $36\text{k}\Omega$  will be used for  $R_F$ . This was determined by Equation 3.

$$A_V = -\frac{R_F}{R_I} \quad (3)$$

## REVISION HISTORY

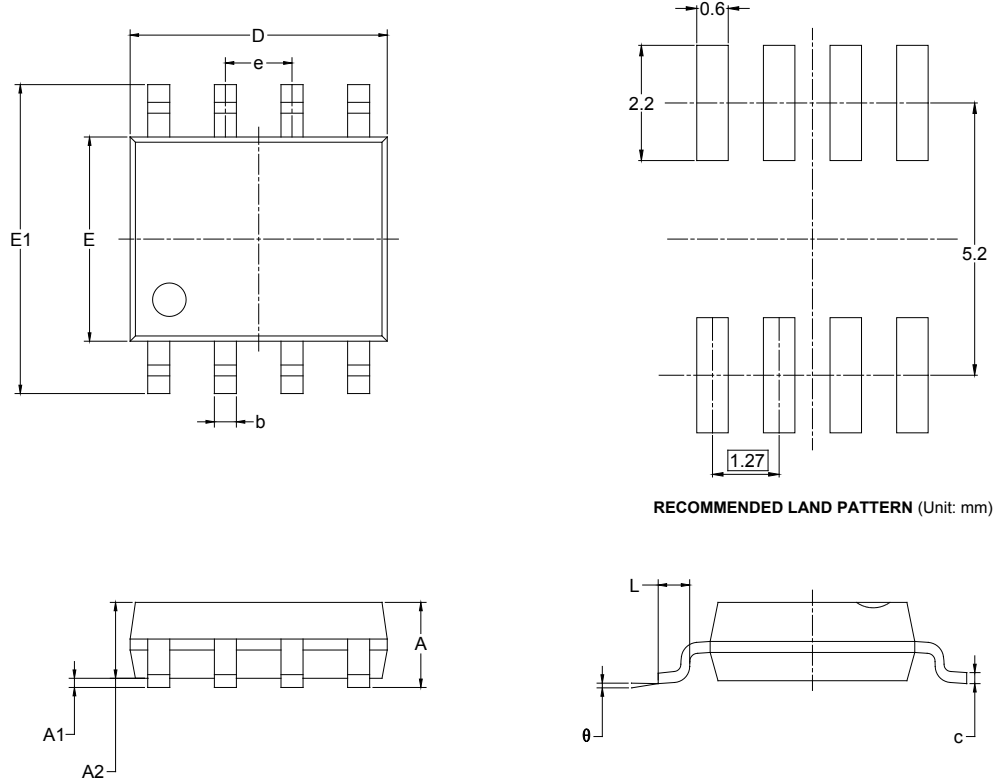
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

### Changes from Original (DECEMBER 2017) to REV.A

|                                                      | Page |
|------------------------------------------------------|------|
| Changed from product preview to production data..... | All  |

## PACKAGE OUTLINE DIMENSIONS

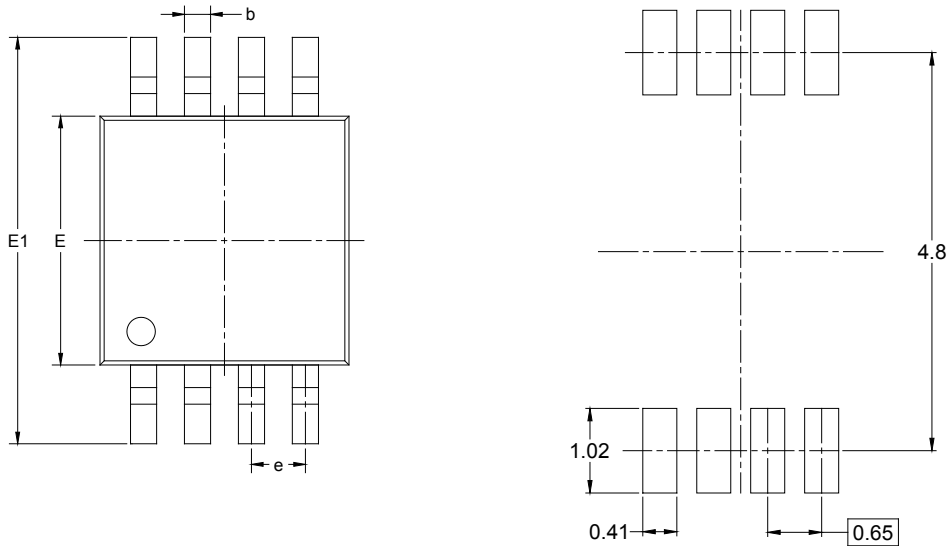
### SOIC-8



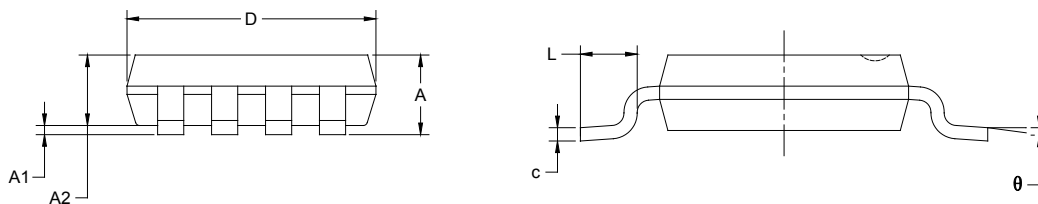
| Symbol   | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|----------|------------------------------|-------|-------------------------|-------|
|          | MIN                          | MAX   | MIN                     | MAX   |
| A        | 1.350                        | 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 |
| $\theta$ | 0°                           | 8°    | 0°                      | 8°    |

## PACKAGE OUTLINE DIMENSIONS

### MSOP-8



RECOMMENDED LAND PATTERN (Unit: mm)

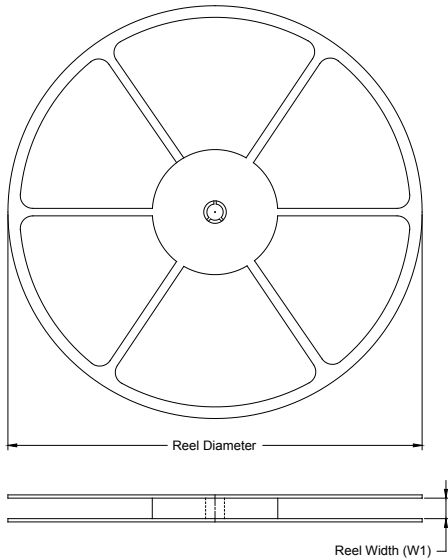


| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 0.820                        | 1.100 | 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°    |

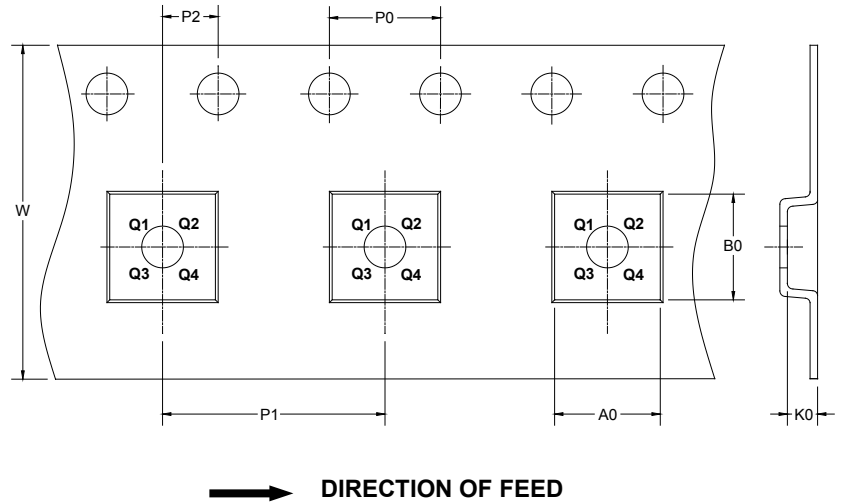
# PACKAGE INFORMATION

## TAPE AND REEL INFORMATION

### REEL DIMENSIONS



### TAPE DIMENSIONS



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

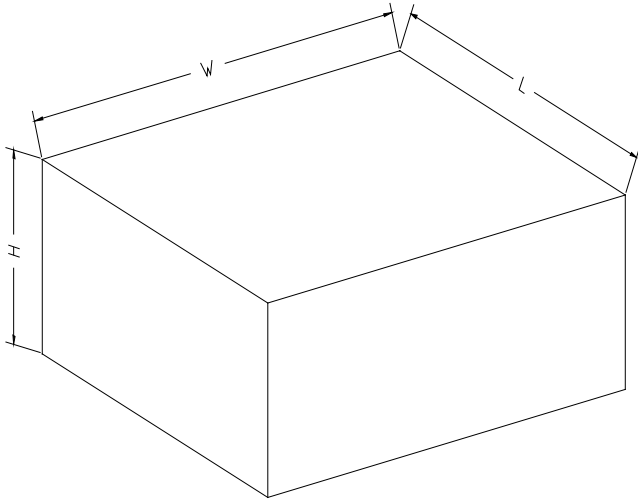
### KEY PARAMETER LIST OF TAPE AND REEL

| Package Type | Reel Diameter | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|--------------|---------------|--------------------|---------|---------|---------|---------|---------|---------|--------|---------------|
| 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 |
|-----------|-------------|------------|-------------|--------------|
| 13"       | 386         | 280        | 370         | 5            |

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