# SGM8045
# 710nA, Non-Unity Gain, Single Rail-to-Rail Input/Output Operational Amplifier

## PRODUCT DESCRIPTION

The SGM8045 operates with a single supply voltage as low as 1.4V, while drawing less than 710nA (TYP) of quiescent current. This device is also designed to support rail-to-rail input and output operation. This combination of features supports battery-powered and portable applications.

The SGM8045 has a gain-bandwidth product of 100kHz (TYP) and is stable for gains of 10. The combination of characteristics makes the SGM8045 ideal for low frequency applications, such as battery current monitoring and sensor conditioning.

The SGM8045 operational amplifier is offered in single configuration and it is specified for the extended industrial (-40℃ to +85℃) temperature range. The SGM8045 is available in the Green SOT-23-5L, SOP8 and MSOP8 packages.

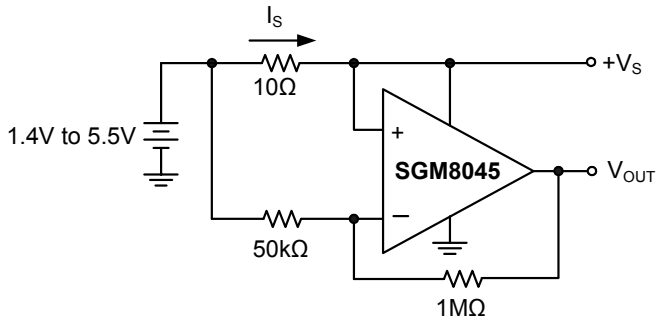
## FEATURES

- **Low Quiescent Current: 710nA (TYP)**
- **Rail-to-Rail Input and Output**
- **Gain Bandwidth Product: 100kHz (TYP)**
- **Wide Supply Voltage Range: 1.4V to 5.5V**
- **Stable for Gains of 10**
- **-40°C to +85°C Operating Temperature Range**
- **Available in Green SOT-23-5L, SOP8 and MSOP8 Packages**

## APPLICATIONS

Toll Booth Tags
Wearable Products
Temperature Measurement
Battery Powered System

## TYPICAL APPLICATION

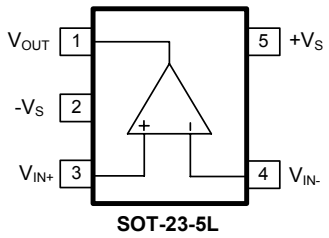



$$I_S = \frac{+Vs - V_{OUT}}{(20V/V) \cdot (10\Omega)}$$

**High Side Battery Current Sensor**

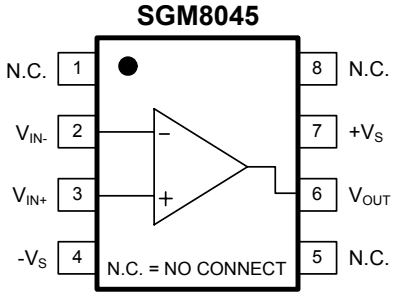
## PIN CONFIGURATIONS (Top View)

**SGM8045**




**SOT-23-5L**

**SGM8045**




**SOP8/MSOP8**

## PACKAGE/ORDERING INFORMATION

| MODEL | ORDER NUMBER | PACKAGE DESCRIPTION | PACKAGE OPTION | MARKING INFORMATION |
|---|---|---|---|---|
| SGM8045 | SGM8045YN5G/TR | SOT-23-5L | Tape and Reel, 3000 | S25XX |
| | SGM8045YS8G/TR | SOP8 | Tape and Reel, 2500 | SGM8045YS8 |
| | SGM8045YMS8G/TR | MSOP8 | Tape and Reel, 3000 | SGM8045YMS8 |

NOTE: Order number and package marking are defined as the follow:

**ORDER NUMBER**

**SGM8045 X X G / TR**

- **Tape and Reel**
- **Green Product**
- **Package Type**
  - N5 SOT-23-5L
  - S8 SOP8
  - MS8 MSOP8
- **Operating Temperature Range**
  - Y -40℃ to +85℃

**MARKING INFORMATION**

**S25 X X**

- Date code - month ("A" = Jan. "B" = Feb. ··· "L" = Dec.)
- Date code - year ("9" = 2009, "A" = 2010 ···)
- Chip I.D.

For example: S259A (2009, January)

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage. . . . . 6V
Analog Inputs ($V_{IN+}$, $V_{IN-}$). . . . . ($-V_S$) - 0.1V to ($+V_S$) + 0.1V
Differential Input Voltage . . . . . | ($-V_S$) – ($+V_S$) |
Storage Temperature Range . . . . . -65℃ to +150℃
Junction Temperature . . . . . 150℃
Operating Temperature Range . . . . . -40℃ to +85℃
Lead Temperature Range (Soldering 10 sec)
. . . . . 260℃
ESD Susceptibility
HBM . . . . . 2000V
MM . . . . . 400V

NOTE:
Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## 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.

# ELECTRICAL CHARACTERISTICS

$+V_S$ = +1.4V to +5.0V, $-V_S$ = GND, $T_A$ = +25°C, $A_V$ = 10, $V_{CM}$ = $+V_S$ / 2, $V_{OUT}$ ≈ $+V_S$ / 2 and $R_L$ = 1MΩ to $+V_S$ / 2 (1), unless otherwise noted.

| PARAMETER | | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **DC ELECTRICAL CHARACTERISTICS** | | | | | | |
| Input Offset Voltage ($V_{OS}$) | | $V_{CM}$ = $+V_S$/2 | | 0.4 | 2.5 | mV |
| Input Offset Voltage Drift ($\Delta V_{OS}/\Delta_T$) | | $V_{CM}$ = $+V_S$/2, -40℃ ≤ $T_A$ ≤ +85℃ | | 2.5 | | μV/°C |
| Power Supply Rejection Ratio (PSRR) | | $+V_S$ = 1.4V to 5.5V | 76 | 80 | | dB |
| Common-Mode Input Range ($V_{CMR}$) | | | -Vs - 0.1 | | +Vs + 0.1 | V |
| Common-Mode Rejection Ratio (CMRR) | | $+V_S$ = 5.0V, $V_{CM}$ = -0.1V to 5.1V | 68 | 84 | | dB |
| | | $+V_S$ = 5.0V, $V_{CM}$ = 2.5V to 5.1V | 67 | 83 | | |
| | | $+V_S$ = 5.0V, $V_{CM}$ = -0.1V to 2.5V | 63 | 78 | | |
| Large Signal Voltage Gain ($A_{VO}$) | | $+V_S$ = 1.4V, $R_L$ = 50kΩ, $V_{OUT}$ = $+V_S$ - 0.1V | 70 | 80 | | dB |
| | | $+V_S$ = 2.5V, $R_L$ = 50kΩ, $V_{OUT}$ = $+V_S$ - 0.1V | | 88 | | |
| | | $+V_S$ = 5.0V, $R_L$ = 50kΩ, $V_{OUT}$ = $+V_S$ - 0.1V | 80 | 93 | | |
| Input Bias Current ($I_B$) | | | | 1 | | pA |
| Input Offset Current ($I_{OS}$) | | | | 1 | | pA |
| Maximum Output Voltage Swing | $V_{OH}$ | $+V_S$ = 1.4V, $R_L$ = 50kΩ | 1.390 | 1.395 | | V |
| | | $+V_S$ = 2.5V, $R_L$ = 50kΩ | | 2.497 | | |
| | | $+V_S$ = 5.0V, $R_L$ = 50kΩ | 4.990 | 4.997 | | |
| | $V_{OL}$ | $+V_S$ = 1.4V, $R_L$ = 50kΩ | | 4.5 | 10 | mV |
| | | $+V_S$ = 2.5V, $R_L$ = 50kΩ | | 3.0 | | |
| | | $+V_S$ = 5.0V, $R_L$ = 50kΩ | | 3.5 | 10 | |
| Short Circuit Current ($I_{SC}$) | | $+V_S$ = 2.5V | | 5.5 | | mA |
| | | $+V_S$ = 5.0V | 22 | 24 | | |
| Supply Voltage | | | 1.4 | | 5.5 | V |
| Quiescent Current ($I_Q$) | | $+V_S$ = 1.4V | | 600 | | nA |
| | | $+V_S$ = 2.5V | | 660 | | |
| | | $+V_S$ = 5.0V | | 710 | 1500 | |

Specifications subject to changes without notice.

# ELECTRICAL CHARACTERISTICS

$+V_S$ = +1.4V to +5.0V, $-V_S$ = GND, $T_A$ = +25°C, $A_V$ = 10, $V_{CM}$ = $+V_S$ / 2, $V_{OUT}$ ≈ $+V_S$ / 2 and $R_L$ = 1MΩ to $+V_S$ / 2, $C_L$ = 60pF (1), unless otherwise noted.

| PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| **AC ELECTRICAL CHARACTERISTICS** | | | | | |
| Gain-Bandwidth Product | | | 100 | | kHz |
| Slew Rate (SR) | $+V_S$ = 1.4V, $V_{OUT}$ = 1V Step | | 13.5 | | V/ms |
| | $+V_S$ = 2.5V, $V_{OUT}$ = 1V Step | | 15 | | |
| | $+V_S$ = 5.0V, $V_{OUT}$ = 2V Step | | 16 | | |
| Phase Margin (PM) | $+V_S$ = 1.4V to 5.5V | | 60 | | ° |
| Input Voltage Noise ($e_n$ p-p) | $+V_S$ = 1.4V, f = 0.1Hz to 10Hz | | 3.6 | | $\mu V_{P-P}$ |
| | $+V_S$ = 2.5V, f = 0.1Hz to 10Hz | | 3.2 | | |
| | $+V_S$ = 5.0V, f = 0.1Hz to 10Hz | | 3.2 | | |
| Input Voltage Noise Density ($e_n$) | $+V_S$ = 1.4V, f = 1kHz | | 170 | | $nV/\sqrt{HZ}$ |
| | $+V_S$ = 2.5V, f = 1kHz | | 160 | | |
| | $+V_S$ = 5.0V, f = 1kHz | | 160 | | |

**NOTE1:** Refer to Figure 1 and Figure 2.

Specifications subject to changes without notice.

# TEST CIRCUITS

The test circuits used for the DC and AC tests are shown in Figure 1 and Figure 2. The bypass capacitors are laid out according to the rules discussed in **"Supply Bypass"**.

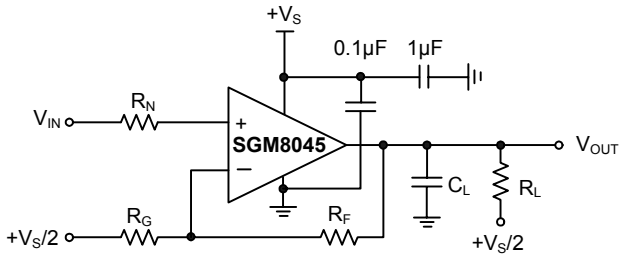



Figure 1. AC and DC Test Circuit for Most Non-Inverting Gain Conditions.

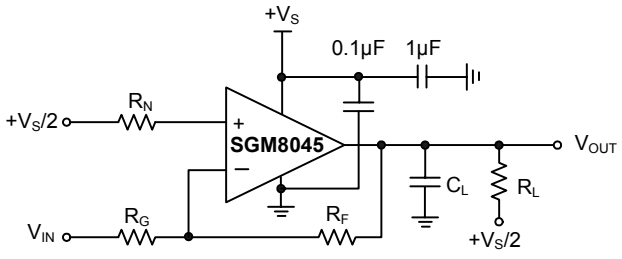
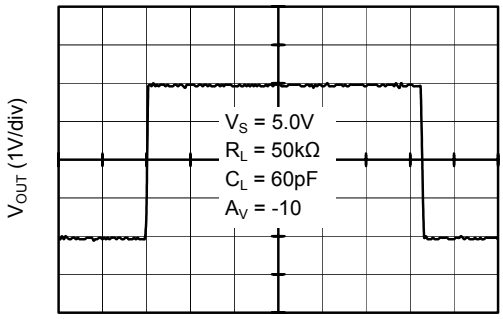



Figure 2. AC and DC Test Circuit for Most Inverting Gain Conditions.

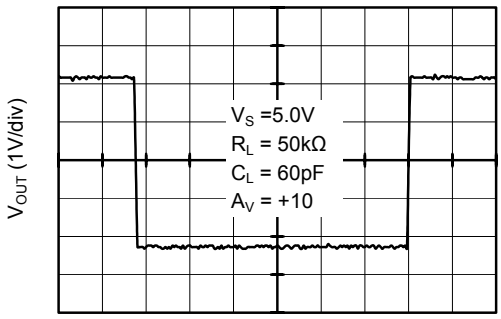
## TYPICAL PERFORMANCE CHARACTERISTICS

$T_A$ = +25°C, $+V_S$ = +1.4V to +5.0V, $-V_S$ = GND, $A_V$ = 10, $V_{CM}$ = $+V_S$ / 2, $V_{OUT}$ ≈ $+V_S$ / 2 and $R_L$ = 1MΩ to $+V_S$ / 2, $C_L$ = 60pF, unless otherwise noted.

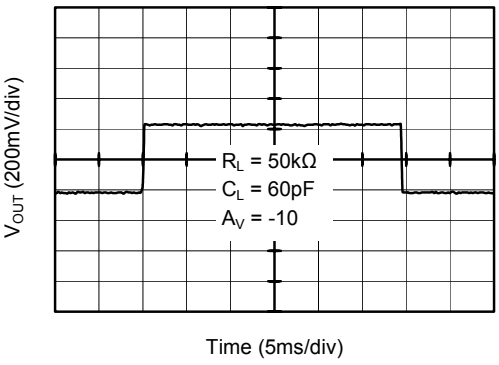
Large Signal Inverting Pulse Response



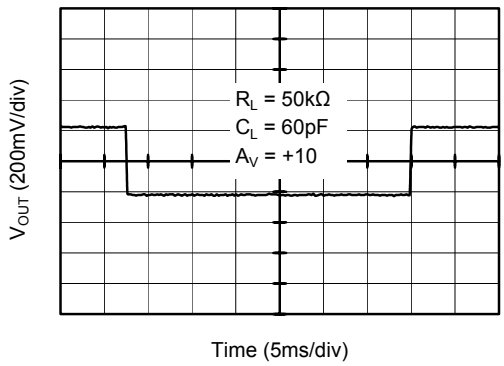

Large Signal Non-Inverting Pulse Response



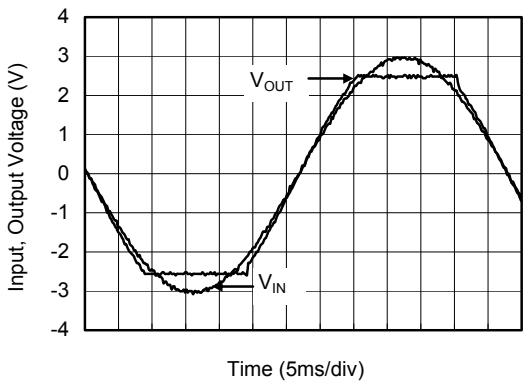

Small Signal Inverting Pulse Response



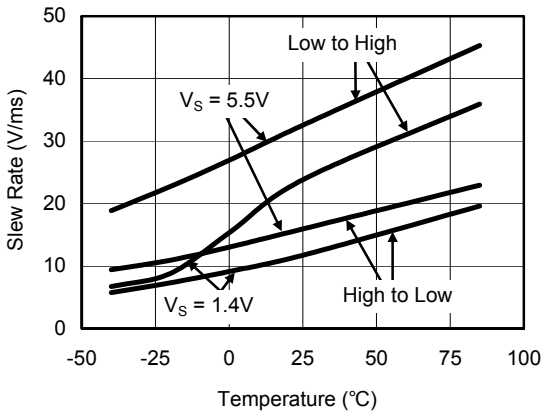

Small Signal Non-Inverting Pulse Response




No Phase Reversal

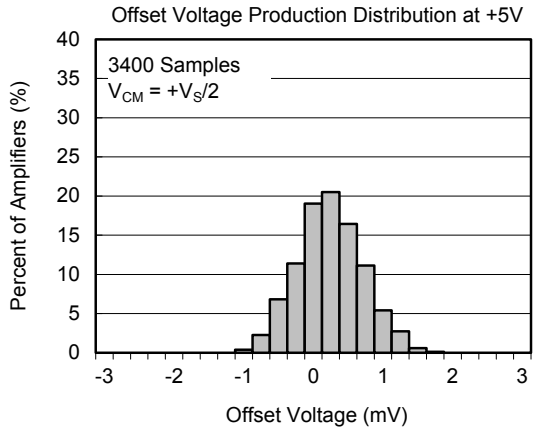


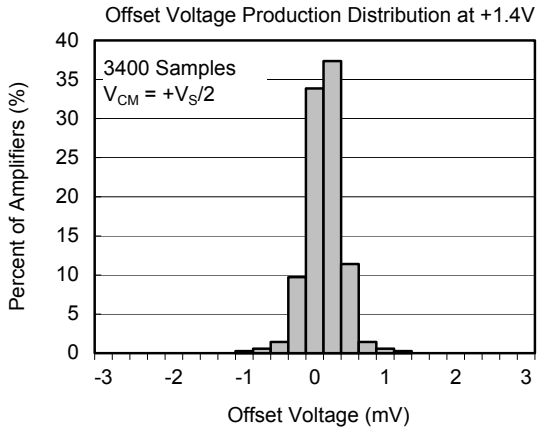

Slew Rate vs. Temperature



## TYPICAL PERFORMANCE CHARACTERISTICS

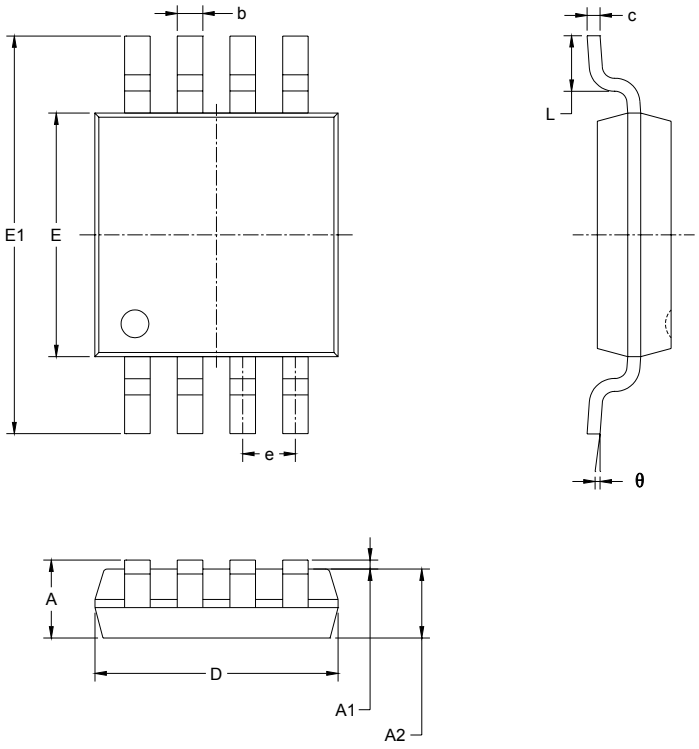
$T_A$ = +25°C, $+V_S$ = +1.4V to +5.0V, $-V_S$ = GND, $A_V$ = 10, $V_{CM}$ = $+V_S$ / 2, $V_{OUT}$ ≈ $+V_S$ / 2 and $R_L$ = 1MΩ to $+V_S$ / 2, $C_L$ = 60pF, unless otherwise noted.



# PACKAGE OUTLINE DIMENSIONS

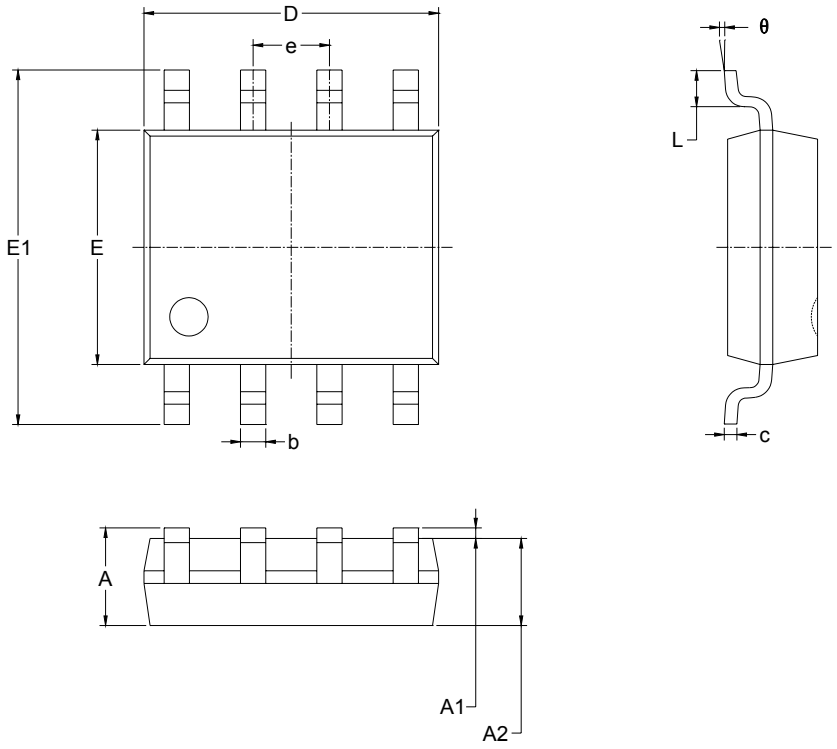
## MSOP8




| 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 | 0.650 BSC | | 0.026 BSC | |
| E | 2.900 | 3.100 | 0.114 | 0.122 |
| E1 | 4.750 | 5.050 | 0.187 | 0.199 |
| L | 0.400 | 0.800 | 0.016 | 0.031 |
| θ | 0° | 6° | 0° | 6° |

# PACKAGE OUTLINE DIMENSIONS

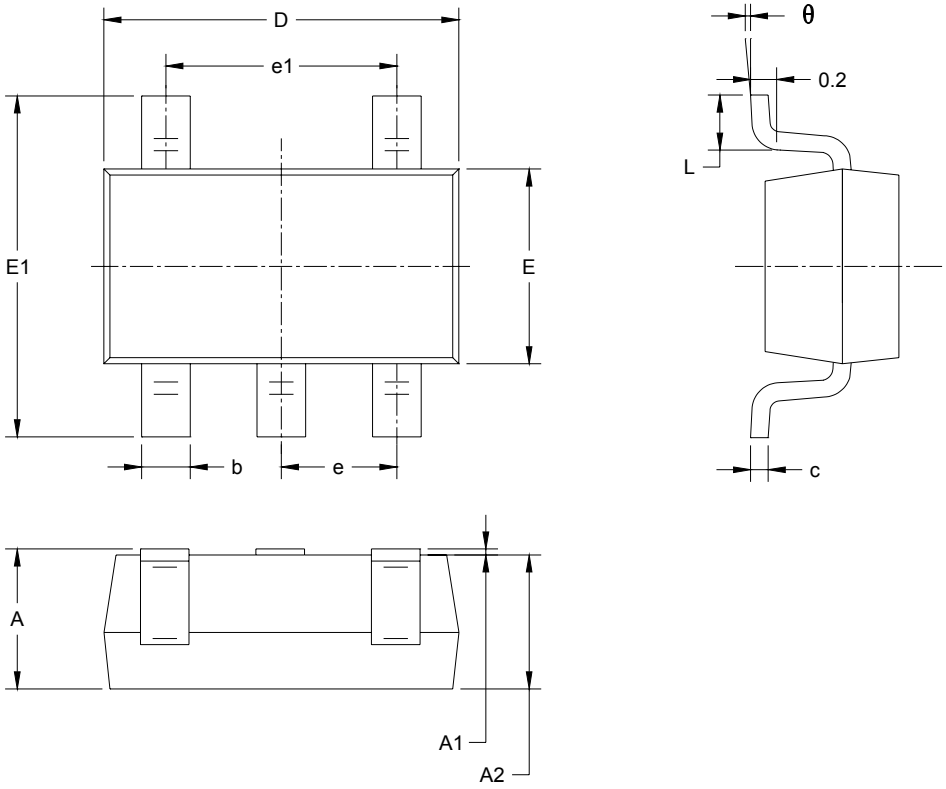
## SOP8




| 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 | 1.270 BSC | | 0.050 BSC | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

# PACKAGE OUTLINE DIMENSIONS

## SOT-23-5L




| 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 | 1.800 | 2.000 | 0.071 | 0.079 |
| L | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |

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