

## Features

- Single-Supply Operation from +1.8V ~ +5.5V
- Low Offset Voltage: 30 $\mu$ V (Max@25°C)
- Zero Drift: 0.01 $\mu$ V/°C (Typ)
- Gain-Bandwidth Product: 1.8MHz (Typ@25°C)
- Low Input Bias Current: 20pA (Typ@25°C)
- Quiescent Current: 180 $\mu$ A per Amplifier (Typ)
- Operating Temperature: -45°C ~ +125°C
- Embedded RF Anti-EMI Filter
- Rail-to-Rail Input / Output
- Small Package:  
 BL3891 Available in SOT23-5 and SOP-8 Packages  
 BL3892 Available in MSOP-8 and SOP-8 Packages  
 BL3894 Available in SOP-14 and TSSOP-14 Packages

## General Description

BL389X series operates from a single 1.8V to 5.5V supply or dual  $\pm 0.9$ V to  $\pm 2.75$ V supplies, the amplifiers offer bandwidth of 1.8MHz, rail-to-rail inputs and outputs. The BL389X amplifier is micro-power, zero-drift CMOS operational amplifiers, BL389X uses chopper stabilized technique to provide very low offset voltage (less than 30 $\mu$ V maximum) and near zero drift over temperature. The BL389X offers excellent CMRR without the crossover associated with traditional complementary input stages. The BL3891 is available in SOT23-5 and SOP-8 packages. And the BL3892 is available in MSOP-8 and SOP-8 packages. The BL3894 Quad is available in Green SOP-14 and TSSOP-14 packages.

## Applications

- Automatic control
- ECG equipment
- Medical equipment
- Internet of Things

## Package/Ordering Information

| MODEL  | CHANNEL | ORDER NUMBER | PACKAGE DESCRIPTION | PACKAGE OPTION     |
|--------|---------|--------------|---------------------|--------------------|
| BL3891 | Single  | BL3891FR     | SOT23-5             | Tape and Reel,3000 |
| BL3892 | Dual    | BL3892SR     | SOP-8               | Tape and Reel,4000 |
|        |         | BL3892MR     | MSOP-8              | Tape and Reel,3000 |
| BL3894 | Quad    | BL3894TR     | TSSOP-14            | Tape and Reel,3000 |
|        |         | BL3894SR     | SOP-14              | Tape and Reel,2500 |

## Pin Configuration

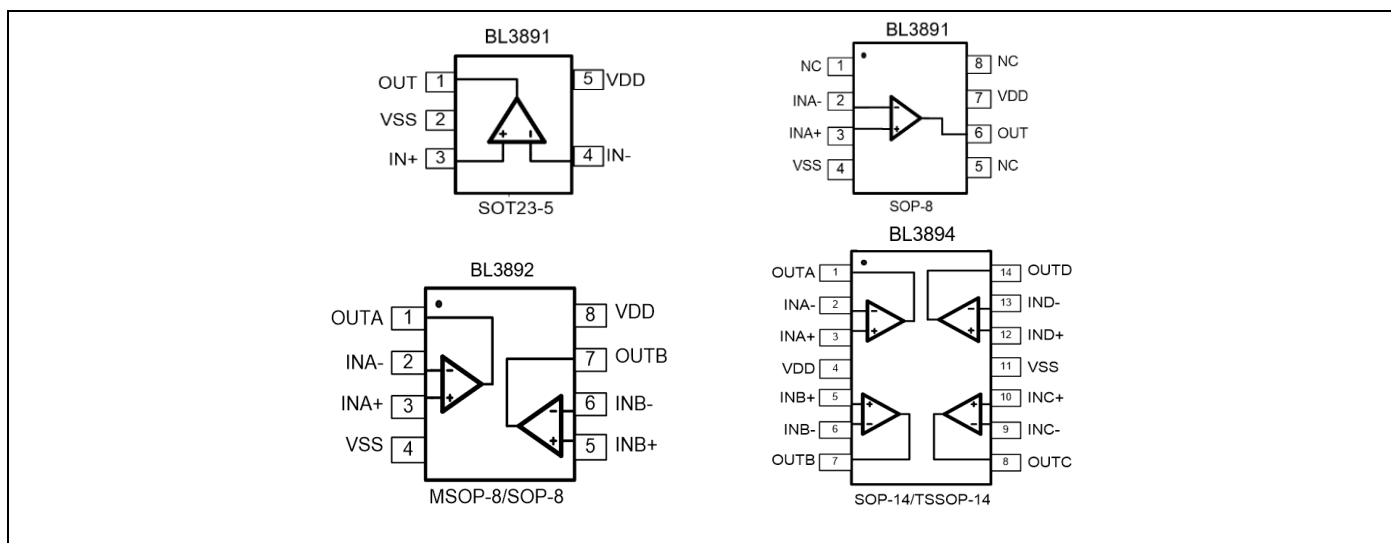


Figure 1. Pin Assignment Diagram

## Absolute Maximum Ratings

| Condition                                                  | Min                   | Max                   |
|------------------------------------------------------------|-----------------------|-----------------------|
| Power Supply Voltage (V <sub>DD</sub> to V <sub>SS</sub> ) | -0.5V                 | +7.5V                 |
| Analog Input Voltage (IN+ or IN-)                          | V <sub>SS</sub> -0.5V | V <sub>DD</sub> +0.5V |
| PDB Input Voltage                                          | V <sub>SS</sub> -0.5V | +7V                   |
| Operating Temperature Range                                | -45°C                 | +125°C                |
| Junction Temperature                                       | +160°C                |                       |
| Storage Temperature Range                                  | -55°C                 | +150°C                |
| Lead Temperature (soldering, 10sec)                        | +260°C                |                       |
| Package Thermal Resistance (T <sub>A</sub> =+25°C)         |                       |                       |
| SOP-8, θ <sub>JA</sub>                                     | 125°C/W               |                       |
| MSOP-8, θ <sub>JA</sub>                                    | 216°C/W               |                       |
| SOT23-5, θ <sub>JA</sub>                                   | 190°C/W               |                       |
| ESD Susceptibility                                         |                       |                       |
| HBM                                                        | 6KV                   |                       |
| MM                                                         | 400V                  |                       |

**Note:** Stress greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions outside those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

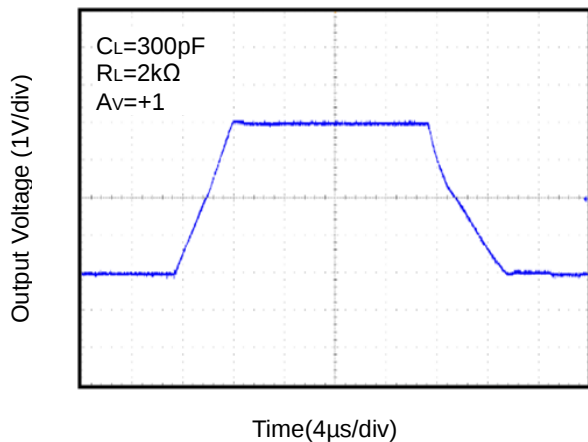
## Electrical Characteristics

( $V_S = +5V$ ,  $V_{CM} = +2.5V$ ,  $V_O = +2.5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

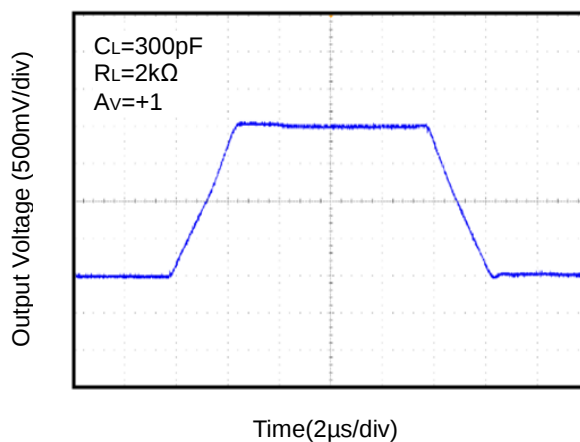
| PARAMETER                                               | CONDITIONS                                 | MIN | TYP   | MAX | UNITS            |
|---------------------------------------------------------|--------------------------------------------|-----|-------|-----|------------------|
| <b>INPUT CHARACTERISTICS</b>                            |                                            |     |       |     |                  |
| Input Offset Voltage ( $V_{OS}$ )                       |                                            |     | 1     | 30  | $\mu V$          |
| Input Bias Current ( $I_B$ )                            |                                            |     | 20    |     | pA               |
| Input Offset Current ( $I_{OS}$ )                       |                                            |     | 10    |     | pA               |
| Common-Mode Rejection Ratio (CMRR)                      | $V_{CM} = 0V$ to $5V$                      |     | 110   |     | dB               |
| Large Signal Voltage Gain ( $A_{VO}$ )                  | $R_L = 10k\Omega$ , $V_O = 0.3V$ to $4.7V$ |     | 145   |     | dB               |
| Input Offset Voltage Drift ( $\Delta V_{OS}/\Delta T$ ) |                                            |     | 10    | 50  | nV/ $^\circ C$   |
| <b>OUTPUT CHARACTERISTICS</b>                           |                                            |     |       |     |                  |
| Output Voltage High ( $V_{OH}$ )                        | $R_L = 100k\Omega$ to $-V_S$               |     | 4.998 |     | V                |
|                                                         | $R_L = 10k\Omega$ to $-V_S$                |     | 4.994 |     | V                |
| Output Voltage Low ( $V_{OL}$ )                         | $R_L = 100k\Omega$ to $+V_S$               |     | 2     |     | mV               |
|                                                         | $R_L = 10k\Omega$ to $+V_S$                |     | 5     |     | mV               |
| Short Circuit Limit ( $I_{SC}$ )                        | $R_L = 10\Omega$ to $-V_S$                 |     | 60    |     | mA               |
| Output Current ( $I_O$ )                                |                                            |     | 65    |     | mA               |
| <b>POWER SUPPLY</b>                                     |                                            |     |       |     |                  |
| Power Supply Rejection Ratio (PSRR)                     | $V_S = 2.5V$ to $5.5V$                     |     | 115   |     | dB               |
| Quiescent Current ( $I_Q$ )                             | $V_O = 0V$ , $R_L = 0\Omega$               |     | 180   |     | $\mu A$          |
| <b>DYNAMIC PERFORMANCE</b>                              |                                            |     |       |     |                  |
| Gain-Bandwidth Product (GBP)                            | $G = +100$                                 |     | 1.8   |     | MHz              |
| Slew Rate (SR)                                          | $R_L = 10k\Omega$                          |     | 0.95  |     | V/ $\mu s$       |
| Overload Recovery Time                                  |                                            |     | 0.10  |     | ms               |
| <b>NOISE PERFORMANCE</b>                                |                                            |     |       |     |                  |
| Voltage Noise ( $e_n$ p-p)                              | 0Hz to 10Hz                                |     | 0.3   |     | $\mu V_{P-P}$    |
| Voltage Noise Density ( $e_n$ )                         | $f = 1kHz$                                 |     | 38    |     | nV / $\sqrt{Hz}$ |

## Typical Performance characteristics

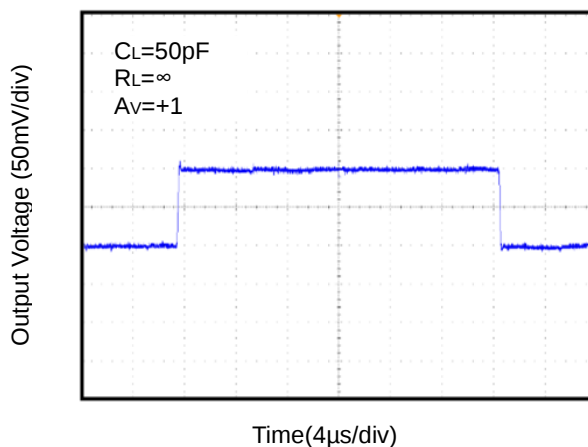
Large Signal Transient Response at +5V



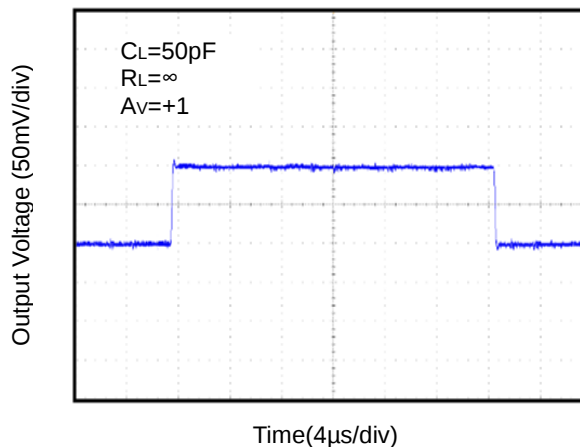
Large Signal Transient Response at +2.5V



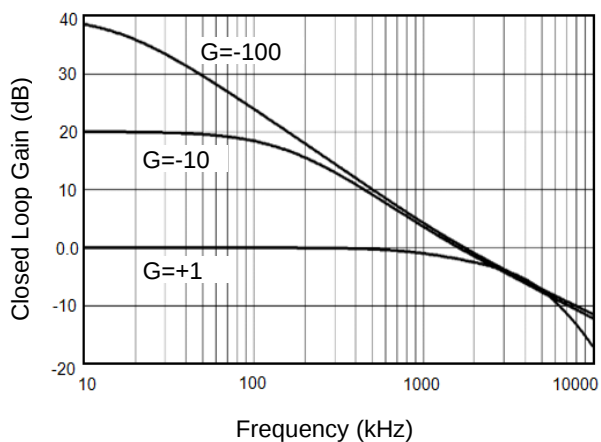
Small Signal Transient Response at +5V



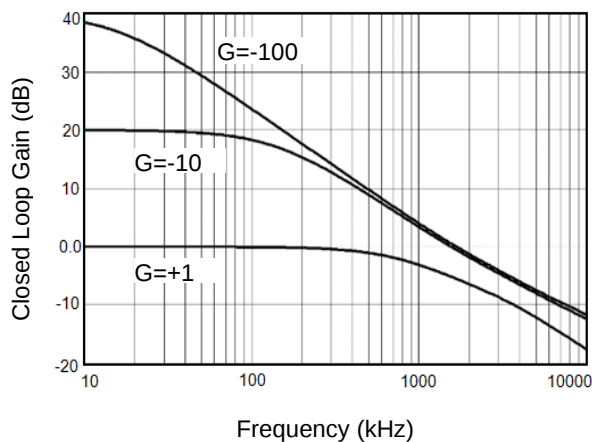
Small Signal Transient Response at +2.5V



Closed Loop Gain vs. Frequency at +5V

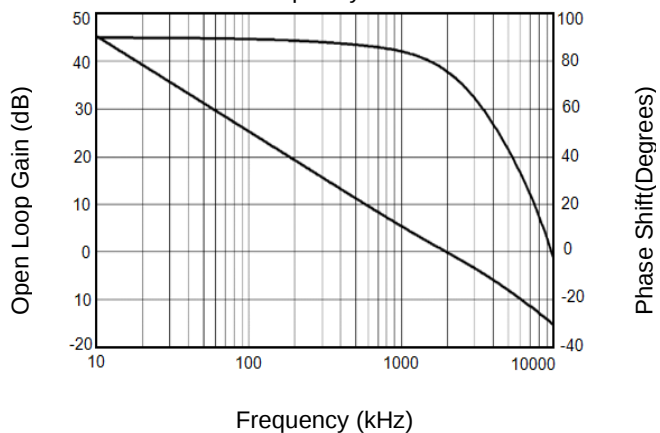


Closed Loop Gain vs. Frequency at +2.5V

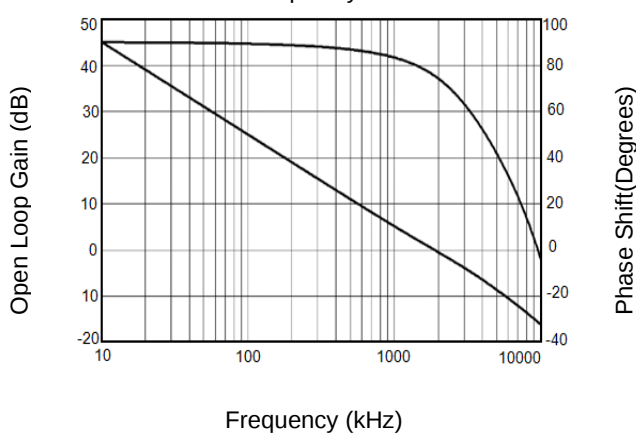


## Typical Performance characteristics

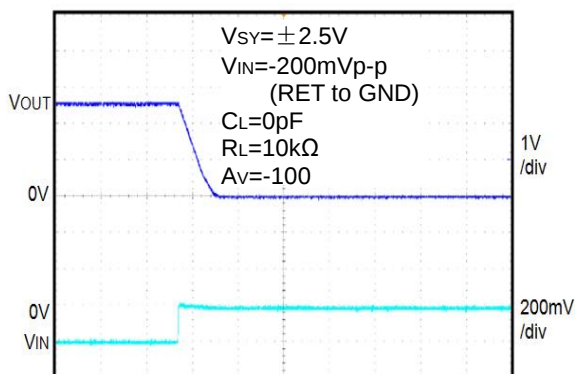
Open Loop Gain, Phase Shift  
vs. Frequency at +5V



Open Loop Gain, Phase Shift  
vs. Frequency at +2.5V

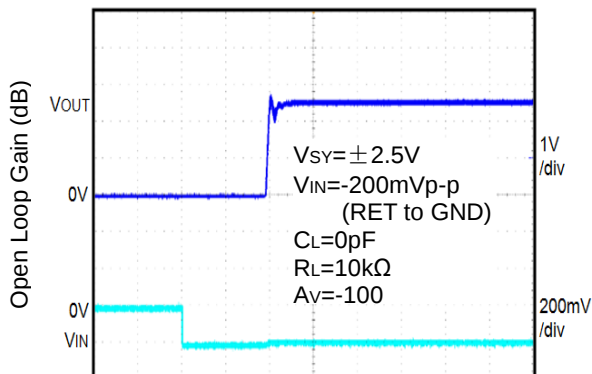


Positive Overvoltage Recovery



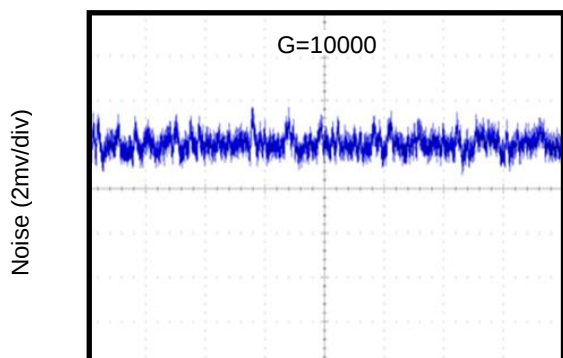
Time (40 $\mu$ s/div)

Negative Overvoltage Recovery



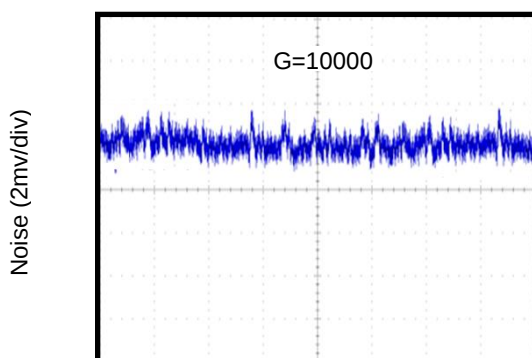
Time (40 $\mu$ s/div)

0.1Hz to 10Hz Noise at +5V



Time (10s/div)

0.1Hz to 10Hz Noise at +2.5V



Time (10s/div)

## Typical Application Circuits

### Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common to the two inputs. It is useful as a computational amplifier in making a differential to single-end conversion or in rejecting a common mode signal. Figure 1. shows the differential amplifier using BL389X.

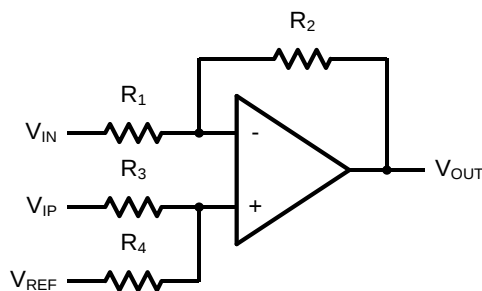


Figure 1. Differential Amplifier

$$V_{OUT} = \left( \frac{R_1 + R_2}{R_3 + R_4} \right) \frac{R_4}{R_1} V_{IN} - \frac{R_2}{R_1} V_{IP} + \left( \frac{R_1 + R_2}{R_3 + R_4} \right) \frac{R_3}{R_1} V_{REF}$$

If the resistor ratios are equal (i.e.  $R_1 = R_3$  and  $R_2 = R_4$ ), then

$$V_{OUT} = \frac{R_2}{R_1} (V_{IP} - V_{IN}) + V_{REF}$$

### Instrumentation Amplifier

The triple BL389X can be used to build a three-op-amp instrumentation amplifier as shown in Figure 2. The amplifier in Figure 2 is a high input impedance differential amplifier with gain of  $R_2/R_1$ . The two differential voltage followers assure the high input impedance of the amplifier.

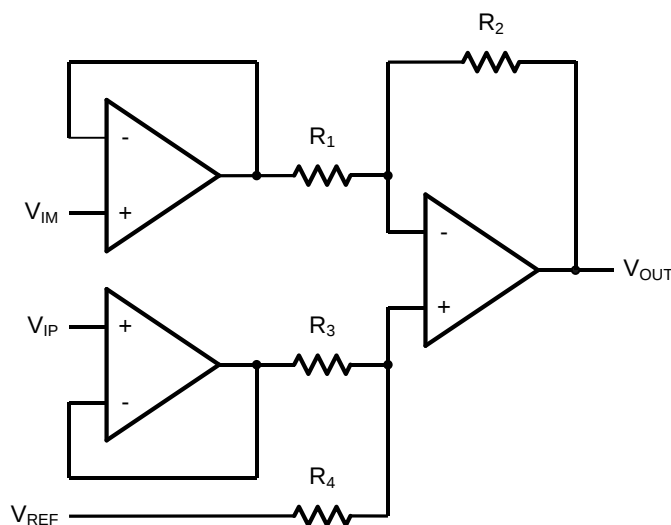
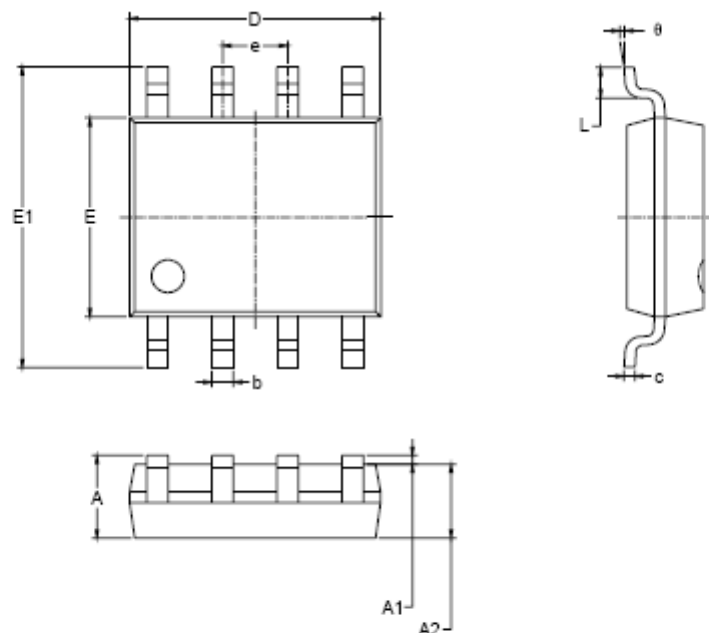


Figure 2. Instrument Amplifier

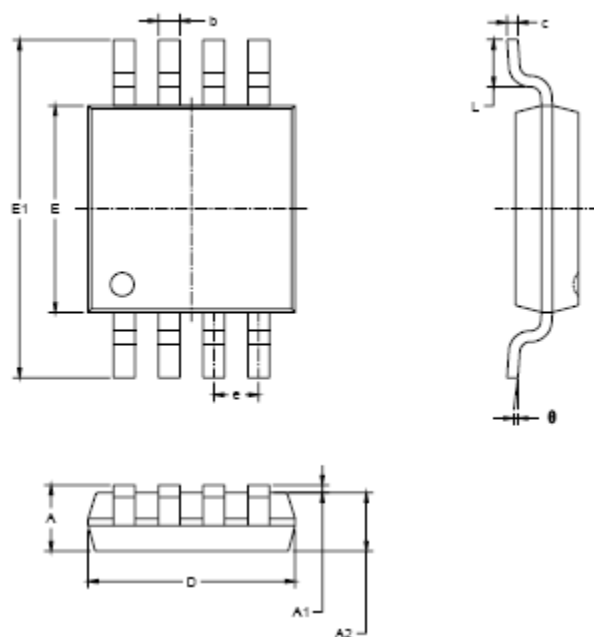
## Package Information

### SOP-8



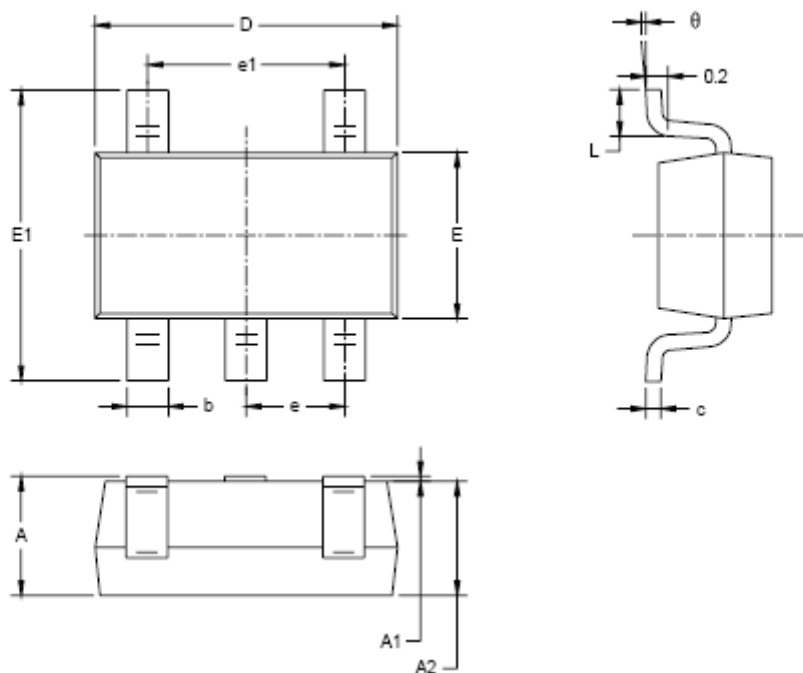
| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 1.350                        | 1.750 | 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 |
| θ      | 0°                           | 8°    | 0°                      | 8°    |

**MSOP-8**



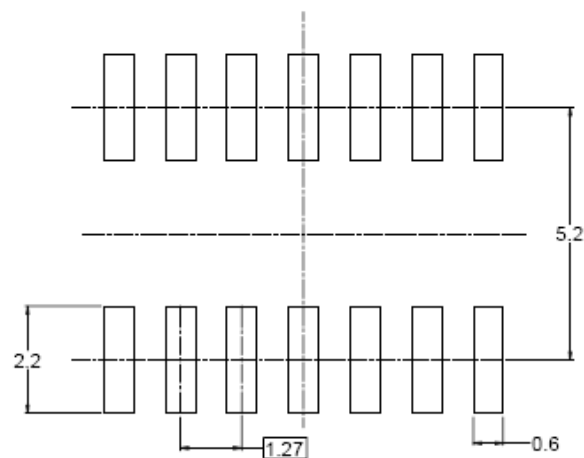
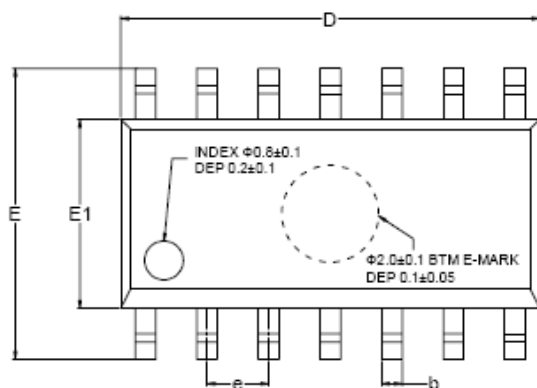
| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 0.820                        | 1.100 |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

**SOT23-5**

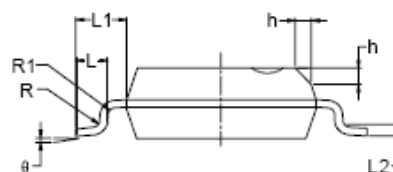
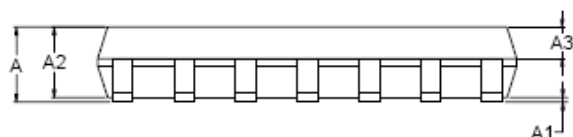


| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 1.050                        | 1.250 | 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 |
| θ      | 0°                           | 8°    | 0°                      | 8°    |

**SOP-14**

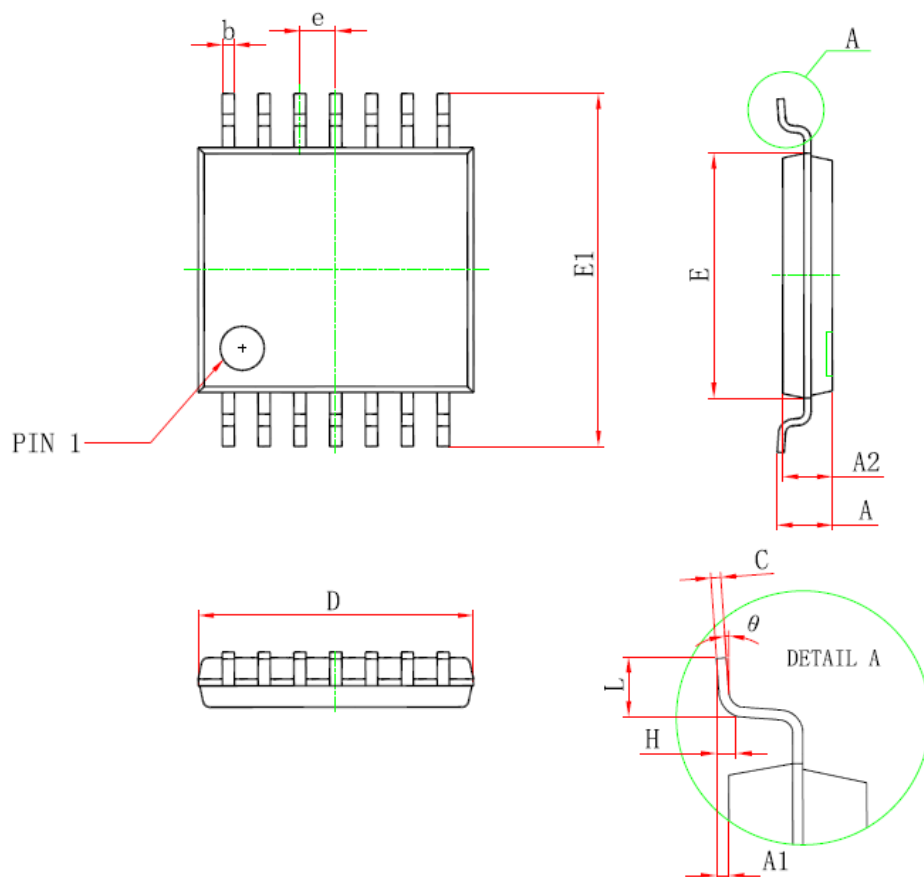


RECOMMENDED LAND PATTERN (Unit: mm)



| Symbol   | Dimensions In Millimeters |     |      | Dimensions In Inches |     |       |
|----------|---------------------------|-----|------|----------------------|-----|-------|
|          | MIN                       | MOD | MAX  | MIN                  | MOD | MAX   |
| A        | 1.35                      |     | 1.75 | 0.053                |     | 0.069 |
| A1       | 0.10                      |     | 0.25 | 0.004                |     | 0.010 |
| A2       | 1.25                      |     | 1.65 | 0.049                |     | 0.065 |
| A3       | 0.55                      |     | 0.75 | 0.022                |     | 0.030 |
| b        | 0.36                      |     | 0.49 | 0.014                |     | 0.019 |
| D        | 8.53                      |     | 8.73 | 0.336                |     | 0.344 |
| E        | 5.80                      |     | 6.20 | 0.228                |     | 0.244 |
| E1       | 3.80                      |     | 4.00 | 0.150                |     | 0.157 |
| e        | 1.27 BSC                  |     |      | 0.050 BSC            |     |       |
| L        | 0.45                      |     | 0.80 | 0.018                |     | 0.032 |
| L1       | 1.04 REF                  |     |      | 0.040 REF            |     |       |
| L2       | 0.25 BSC                  |     |      | 0.01 BSC             |     |       |
| R        | 0.07                      |     |      | 0.003                |     |       |
| R1       | 0.07                      |     |      | 0.003                |     |       |
| h        | 0.30                      |     | 0.50 | 0.012                |     | 0.020 |
| $\theta$ | 0°                        |     | 8°   | 0°                   |     | 8°    |

**TSSOP-14**



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| D      | 4.900                     | 5.100 | 0.193                | 0.201 |
| E      | 4.300                     | 4.500 | 0.169                | 0.177 |
| b      | 0.190                     | 0.300 | 0.007                | 0.012 |
| c      | 0.090                     | 0.200 | 0.004                | 0.008 |
| E1     | 6.250                     | 6.550 | 0.246                | 0.258 |
| A      |                           | 1.200 |                      | 0.047 |
| A2     | 0.800                     | 1.000 | 0.031                | 0.039 |
| A1     | 0.050                     | 0.150 | 0.002                | 0.006 |
| e      | 0.65 (BSC)                |       | 0.026 (BSC)          |       |
| L      | 0.500                     | 0.700 | 0.020                | 0.028 |
| H      | 0.25(TYP)                 |       | 0.01(TYP)            |       |
| θ      | 1°                        | 7°    | 1°                   | 7°    |