

### Features

- Single-Supply Operation from +2.5V ~ +5.5V
- Rail-to-Rail Output
- -3dB Bandwidth(G=+1): 250MHz (Typ.)
- Low Input Bias Current: 1pA (Typ.)
- Quiescent Current: 2.8mA/Amplifier (Typ.)
- Operating Temperature: -40°C ~ +125°C
- Small Package:

- GS8051 Available in SOT23-5 and SC70-5 Packages
- GS8052 Available in SOP-8 and MSOP-8 Packages
- GS8054 Available in SOP-14 and TSSOP-14 Packages
- GS8051N Available in SOT23-6 and SC70-6 Packages
- GS8052N Available in MSOP-10 Packages

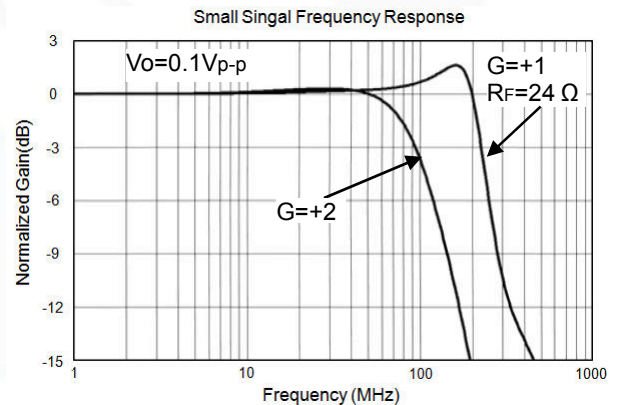
### General Description

The GS8051/1N(single), GS8052/2N(dual), GS8054(quad) are rail-to-rail output voltage feedback amplifiers offering ease of use and low cost. They have bandwidth and slew rate typically found in current feedback amplifiers. All have a wide input common-mode voltage range and output voltage swing, making them easy to use on single supplies as low as 2.5V. Despite being low cost, the GS8051 series provide excellent overall performance. They offer wide bandwidth to 250MHz (G = +1) along with 0.1dB flatness out to 52MHz (G = +2) and offer a typical low power of 2.8mA/amplifier.

The GS8051 series is low distortion and fast settling make it ideal for buffering high speed A/D or D/A converters. The GS8051/2N has a power-down disable feature that reduces the supply current to 50µA. These features make the GS8051/2N ideal for portable and battery-powered applications where size and power are critical. All are specified over the extended -40°C to +125°C temperature range.

### Applications

- Imaging
- Photodiode Preamp
- DVD/CD
- Filters
- Professional Video and Cameras
- Hand Sets
- Base Stations
- A-to-D Driver



## Pin Configuration

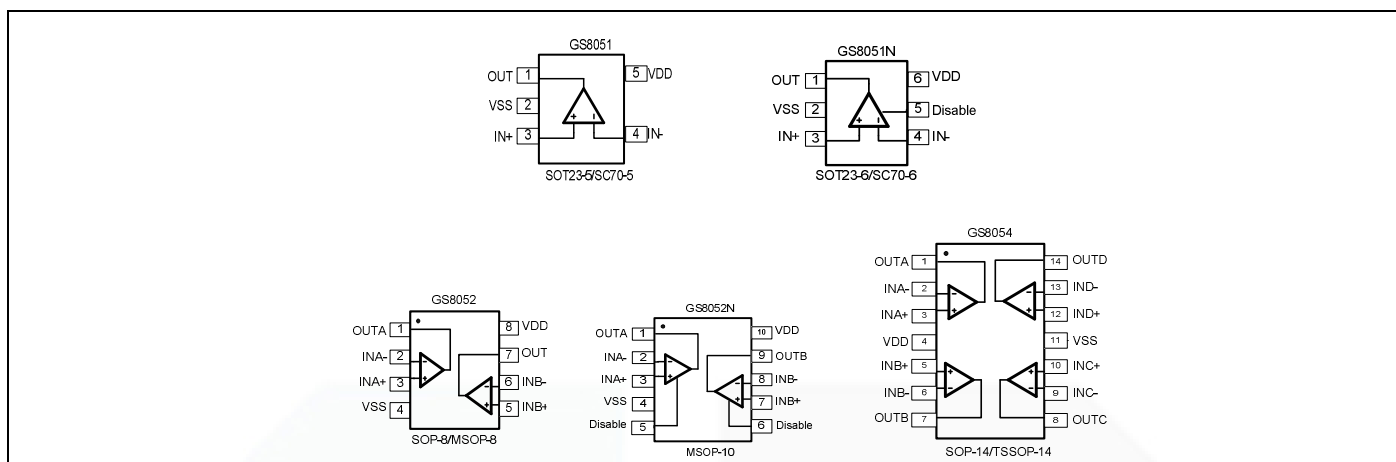


Figure 1. Pin Assignment Diagram

## Absolute Maximum Ratings

| Condition  | Min           | Max           |
|--|---------------|---------------|
| Power Supply Voltage ( $V_{DD}$ to $V_{SS}$ )                          | -0.5V         | +7.5V         |
| Analog Input Voltage (IN+ or IN-)                                      | $V_{SS}-0.5V$ | $V_{DD}+0.5V$ |
| PDB Input Voltage  | $V_{SS}-0.5V$ | +7V           |
| Operating Temperature Range  | -40°C         | +125°C        |
| Junction Temperature   | +160°C        |               |
| Storage Temperature Range  | -55°C         | +150°C        |
| Lead Temperature (soldering, 10sec)                                    | +260°C        |               |
| <b>Package Thermal Resistance (<math>T_A=+25^\circ\text{C}</math>)</b> |               |               |
| SOP-8, $\theta_{JA}$   | 125°C/W       |               |
| MSOP-8, $\theta_{JA}$  | 216°C/W       |               |
| SOT23-5, $\theta_{JA}$   | 190°C/W       |               |
| SOT23-6, $\theta_{JA}$   | 190°C/W       |               |
| SC70-5, $\theta_{JA}$  | 333°C/W       |               |
| <b>ESD Susceptibility</b>  |               |               |
| 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.

## Package/Ordering Information

| MODEL   | CHANNEL              | ORDER NUMBER | PACKAGE DESCRIPTION | PACKAGE OPTION     | MARKING INFORMATION |
|---------|----------------------|--------------|---------------------|--------------------|---------------------|
| GS8051  | Single               | GS8051-CR    | SC70-5              | Tape and Reel,3000 | 8051                |
|         |                      | GS8051-TR    | SOT23-5             | Tape and Reel,3000 | 8051                |
| GS8052  | Dual                 | GS8052-SR    | SOP-8               | Tape and Reel,4000 | GS8052              |
|         |                      | GS8052-MR    | MSOP-8              | Tape and Reel,3000 | GS8052              |
| GS8054  | Quad                 | GS8054-TR    | TSSOP-14            | Tape and Reel,3000 | GS8054              |
|         |                      | GS8054-SR    | SOP-14              | Tape and Reel,2500 | GS8054              |
| GS8051N | Single With shutdown | GS8051N-CR   | SC70-6              | Tape and Reel,3000 | 8051N               |
|         |                      | GS8051N-TR   | SOT23-6             | Tape and Reel,3000 | 8051N               |
| GS8052N | Dual With shutdown   | GS8052N-MR   | MSOP-10             | Tape and Reel,2500 | GS8052N             |

## Electrical Performance Characteristics

(G= +2, R<sub>F</sub>=887Ω, R<sub>G</sub>=887Ω, and R<sub>L</sub>=150Ω connected to V<sub>S</sub>/2, unless otherwise noted. Typical values are at T<sub>A</sub> =+25°C.)

| PARAMETER  | CONDITIONS  | GS8051/52/54/51N/52N |                          |               |                 |                  |  |        |             |
|--|---|----------------------|--------------------------|---------------|-----------------|------------------|--|--------|-------------|
|  |   | TYP                  | MIN/MAX OVER TEMPERATURE |               |                 |                  |  | UNITS  | MIN/<br>MAX |
|  |   | +25°C                | +25°C                    | 0°C<br>to70°C | -40°Cto<br>85°C | -40°C<br>to125°C |  |        |             |
| <b>DYNAMIC PERFORMANCE</b>                         |   |                      |                          |               |                 |                  |  |        |             |
| -3dB Small Signal Bandwidth                        | G = +1, Vo = 0.1V p-p, R <sub>F</sub> = 24 Ω, R <sub>L</sub> = 150Ω | 180                  |                          |               |                 |                  |  | MHz    | TYP         |
|  | G = +1, Vo = 0.1V p-p, R <sub>F</sub> = 24 Ω, R <sub>L</sub> = 1kΩ  | 250                  |                          |               |                 |                  |  | MHz    | TYP         |
|  | G = +2, Vo = 0.1V p-p, R <sub>L</sub> = 50Ω                         | 55                   |                          |               |                 |                  |  | MHz    | TYP         |
|  | G = +2, Vo = 0.1V p-p, R <sub>L</sub> = 150Ω                        | 93                   |                          |               |                 |                  |  | MHz    | TYP         |
|  | G = +2, Vo = 0.1V p-p, R <sub>L</sub> = 1kΩ                         | 122                  |                          |               |                 |                  |  | MHz    | TYP         |
|  | G = +2, Vo = 0.1V p-p, R <sub>L</sub> = 10kΩ                        | 130                  |                          |               |                 |                  |  | MHz    | TYP         |
| Gain-Bandwidth Product                             | G = +10, R <sub>L</sub> = 150Ω                                      | 115                  |                          |               |                 |                  |  | MHz    | TYP         |
|  | G = +10, R <sub>L</sub> = 1kΩ                                       | 150                  |                          |               |                 |                  |  | MHz    | TYP         |
| Bandwidth for 0.1dB Flatness                       | G = +2, Vo = 0.1V p-p, R <sub>L</sub> = 150 Ω, R <sub>F</sub> =887Ω | 52                   |                          |               |                 |                  |  | MHz    | TYP         |
| Slew Rate  | G = +1, 2V Output Step  | 77/-151              |                          |               |                 |                  |  | V/ μ s | TYP         |
|  | G = +2, 2V Output Step  | 88/-119              |                          |               |                 |                  |  | V/ μ s | TYP         |
|  | G = +2, 4V Output Step  | 93/-131              |                          |               |                 |                  |  | V/ μ s | TYP         |
| Rise-and-Fall Time                                 | G = +2, Vo = 0.2V <sub>p-p</sub> , 10% to 90%                       | 4.5                  |                          |               |                 |                  |  | ns     | TYP         |
|  | G = +2, Vo = 2V <sub>p-p</sub> , 10% to 90%                         | 18                   |                          |               |                 |                  |  | ns     | TYP         |
| Settling Time to 0.1%                              | G = +2, 2V Output Step  | 50                   |                          |               |                 |                  |  | ns     | TYP         |
| Overload Recovery Time                             | V <sub>IN</sub> • G = +VS   | 18                   |                          |               |                 |                  |  | ns     | TYP         |
| <b>NOISE/DISTORTION PERFORMANCE</b>                |   |                      |                          |               |                 |                  |  |        |             |
| Input Voltage Noise                                | f = 1MHz  | 4.9                  |                          |               |                 |                  |  | nV/ Hz | TYP         |
| Differential Gain Error (NTSC)                     | G = +2, R <sub>L</sub> = 150Ω                                       | 0.03                 |                          |               |                 |                  |  | %      | TYP         |
| Differential Phase Error (NTSC)                    | G = +2, R <sub>L</sub> = 150Ω                                       | 0.08                 |                          |               |                 |                  |  | degree | TYP         |
| <b>DC PERFORMANCE</b>                              |   |                      |                          |               |                 |                  |  |        |             |
| Input Offset Voltage (V <sub>OS</sub> )            |   | ±2                   | ±8                       | ±8.9          | ±9.5            | ±9.8             |  | mV     | MAX         |
| Input Offset Voltage Drift                         |   | 2                    |                          |               |                 |                  |  | μ V/°C | TYP         |
| Input Bias Current (I <sub>B</sub> )               |   | 1                    |                          |               |                 |                  |  | PA     | TYP         |
| Input offset Current (I <sub>OS</sub> )            |   | 2                    |                          |               |                 |                  |  | PA     | TYP         |
| Open-Loop Gain (A <sub>OL</sub> )                  | V <sub>O</sub> = 0.3V to 4.7V, R <sub>L</sub> = 150Ω                | 80                   | 75                       | 74            | 74              | 73               |  | dB     | MIN         |
|  | V <sub>O</sub> = 0.2V to 4.8V, R <sub>L</sub> = 1kΩ                 | 104                  | 92                       | 91            | 91              | 80               |  | dB     | MIN         |
| <b>INPUT CHARACTERISTICS</b>                       |   |                      |                          |               |                 |                  |  |        |             |
| Input Common-Mode Voltage Range (V <sub>CM</sub> ) |   | -0.2 to +3.8         |                          |               |                 |                  |  | V      | TYP         |
| Common-Mode Rejection Ratio (CMRR)                 | V <sub>CM</sub> = -0.1V to +3.5V                                    | 80                   | 66                       | 65            | 65              | 62               |  | dB     | MIN         |

## Electrical Performance Characteristics

( $G = +2$ ,  $R_F = 887\Omega$ ,  $R_G = 887\Omega$ , and  $R_L = 150\Omega$  connected to  $V_S/2$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ\text{C}$ .)

| PARAMETER   | CONDITIONS   | GS8051/52/54/51N/52N |                          |                |                  |                   |  |               |             |
|---|--|----------------------|--------------------------|----------------|------------------|-------------------|--|---------------|-------------|
|   |  | TYP                  | MIN/MAX OVER TEMPERATURE |                |                  |                   |  | UNITS         | MIN/<br>MAX |
|   |  | +25°C                | +25°C                    | 0°C<br>to 70°C | -40°C to<br>85°C | -40°C<br>to 125°C |  |               |             |
| <b>OUTPUT CHARACTERISTICS</b>                               |  |                      |                          |                |                  |                   |  |               |             |
| Output Voltage Swing from Rail                              | $R_L = 150\Omega$  | 0.12                 |                          |                |                  |                   |  | V             | TYP         |
|   | $R_L = 1k\Omega$   | 0.03                 |                          |                |                  |                   |  | V             | TYP         |
| Output Current  |  | 130                  | 100                      | 95             | 90               | 84                |  | mA            | MIN         |
| Closed-Loop Output Impedance                                | $f < 100\text{kHz}$  | 0.08                 |                          |                |                  |                   |  | $\Omega$      | TYP         |
| <b>POWER-DOWN DISABLE</b><br>(GS8051/2N only)               |  |                      |                          |                |                  |                   |  |               |             |
| Turn-On Time  |  | 236                  |                          |                |                  |                   |  | ns            | TYP         |
| Turn-Off Time   |  | 52                   |                          |                |                  |                   |  | ns            | TYP         |
| DISABLE Voltage-Off   |  |                      | 0.8                      |                |                  |                   |  | V             | MAX         |
| DISABLE Voltage-On  |  |                      | 2                        |                |                  |                   |  | V             | MIN         |
| <b>POWER SUPPLY</b>   |  |                      |                          |                |                  |                   |  |               |             |
| Operating Voltage Range                                     |  |                      | 2.5                      | 2.7            | 2.7              | 2.7               |  | V             | MIN         |
|   |  |                      | 5.5                      | 5.5            | 5.5              | 5.5               |  | V             | MAX         |
| Quiescent Current (per amplifier)                           |  | 2.8                  | 3                        | 3.2            | 3.6              | 3.8               |  | mA            | MAX         |
| Supply Current when Disabled per amplifier (GS8051/2N only) |  | 50                   | 70                       | 85             | 100              | 137               |  | $\mu\text{A}$ | MAX         |
| Power Supply Rejection Ratio (PSRR)                         | $\Delta V_S = +2.7\text{V to } +5.5\text{V}$ , $V_{CM} = (-V_S) + 0.5$ | 80                   | 67                       | 67             | 65               | 62                |  | dB            | MIN         |

**Typical Performance characteristics**

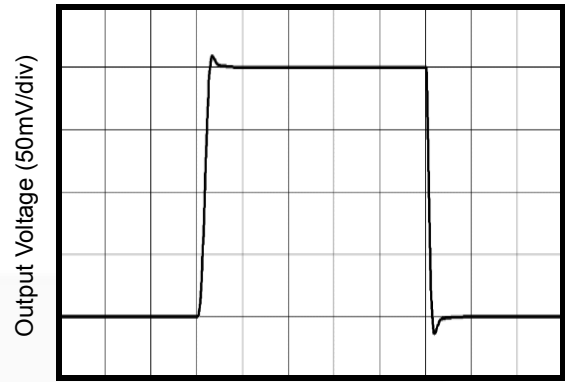
( $V_s=+5V, G= +2, R_F=887\Omega, R_G=887\Omega,$  and  $R_L=150\Omega$  connected to  $V_s/2$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C.$ )

Non-Inverting Large-Signal Step Response



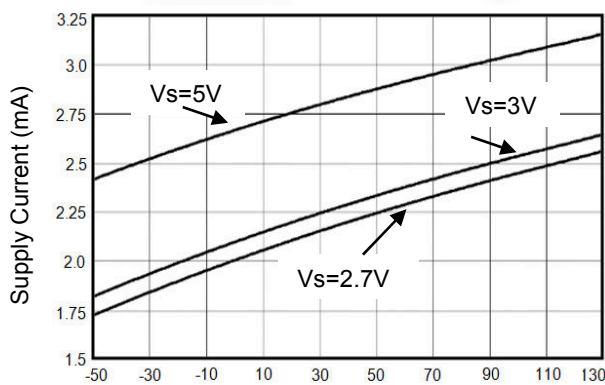
Time (50ns/div)

Non-Inverting Small-Signal Step Response



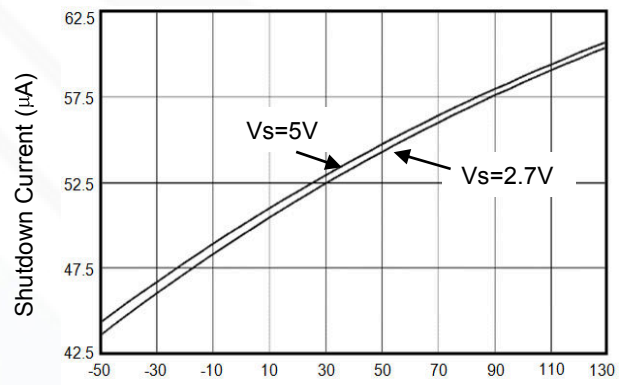
Time (50ns/div)

Supply Current vs. Temperature



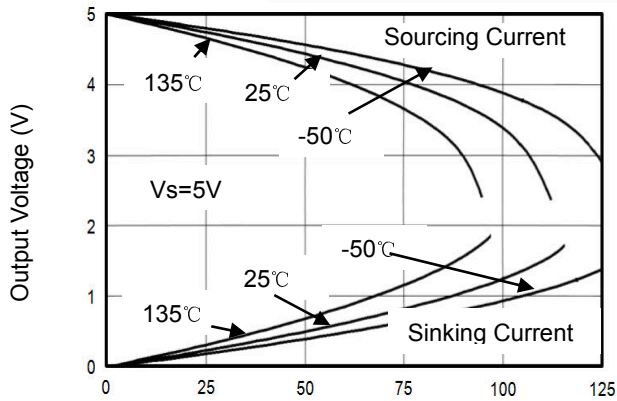
Temperature (°C)

Shutdown Current vs. Temperature



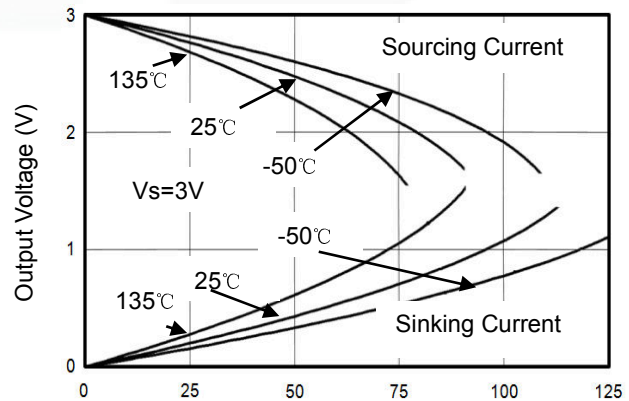
Temperature (°C)

Output Voltage Swing vs. Output Current



Output Current (mA)

Output Voltage vs. Output Current

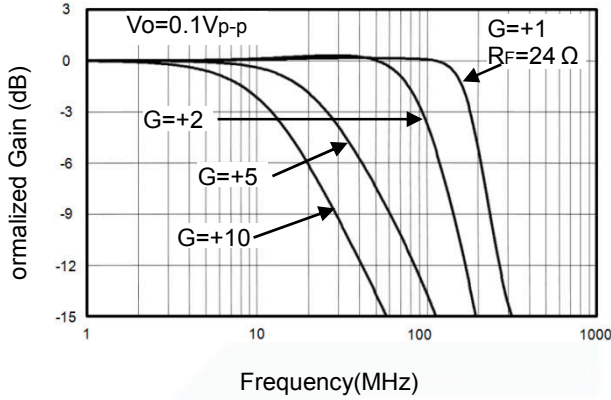


Output Current (mA)

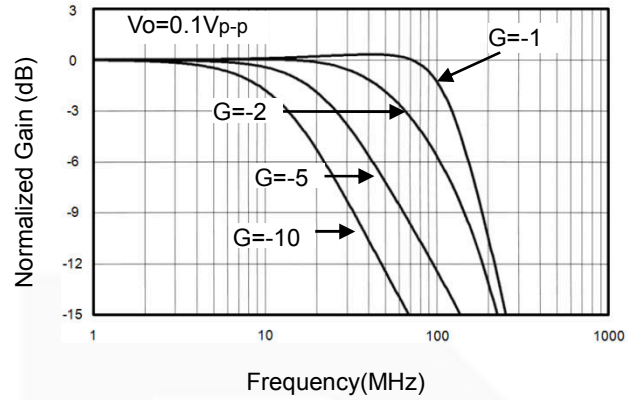
**Typical Performance characteristics**

(( $V_s=+5V, G= +2, R_F=887\Omega, R_G=887\Omega,$  and  $R_L=150\Omega$  connected to  $V_s/2$ , unless otherwise noted. Typical values are at  $T_A =+25^\circ C.$ )

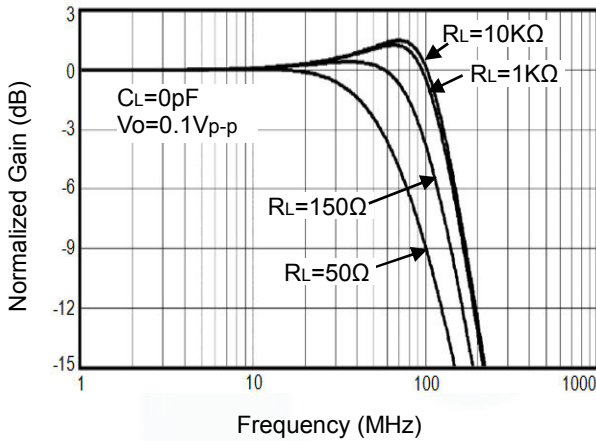
Non-Inverting Small Signal Frequency Response



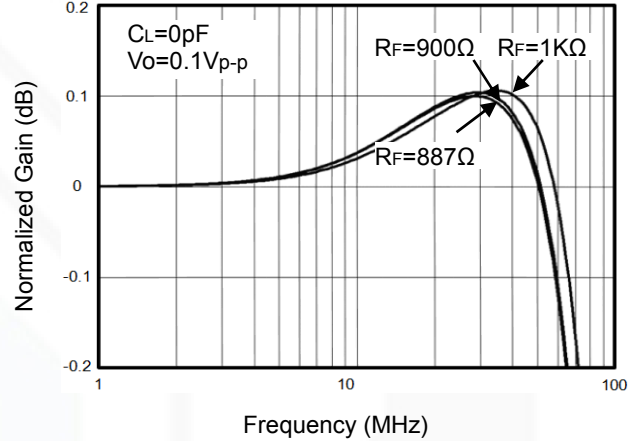
Inverting Small Signal Frequency Response



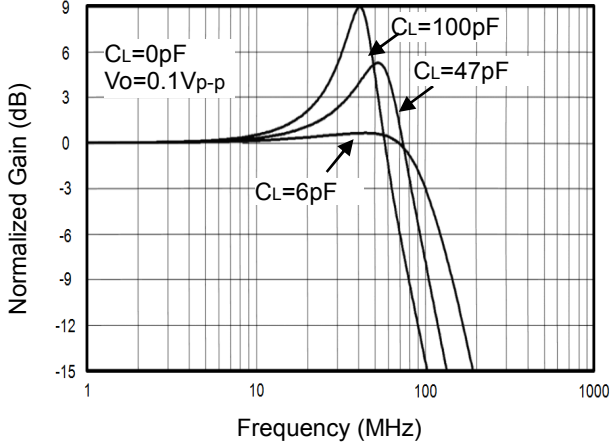
Frequency Response For Various  $R_L$



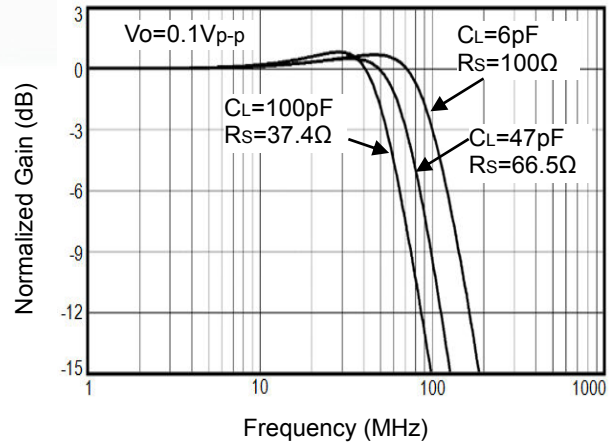
0.1dB Gain Flatness For Various  $R_F$



Frequency Response For Various  $C_L$



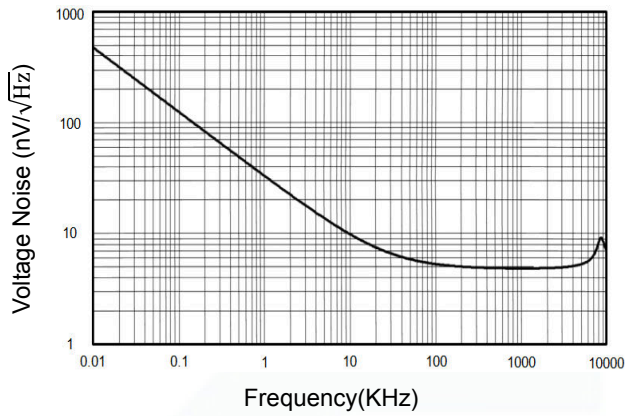
Frequency Response vs. Capacitive Load



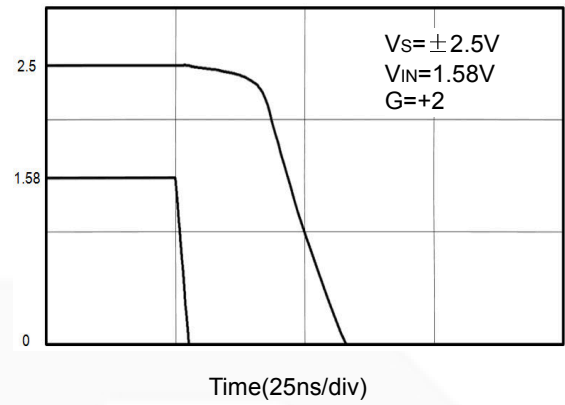
**Typical Performance characteristics**

( $V_S=+5V, G=+2, R_F=887\Omega, R_G=887\Omega,$  and  $R_L=150\Omega$  connected to  $V_S/2$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C.$ )

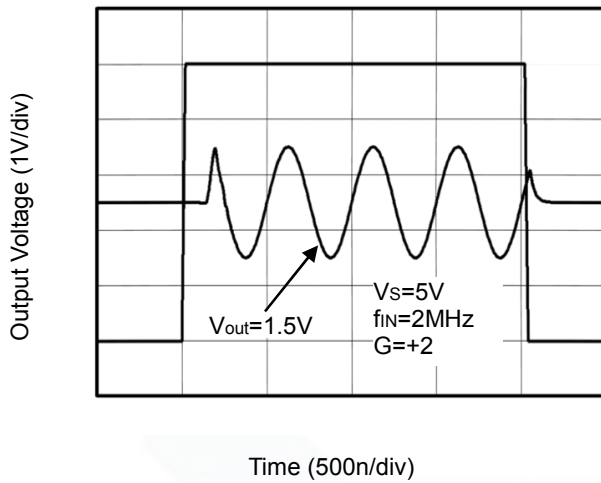
Input Voltage Noise Spectral Density vs. Frequency



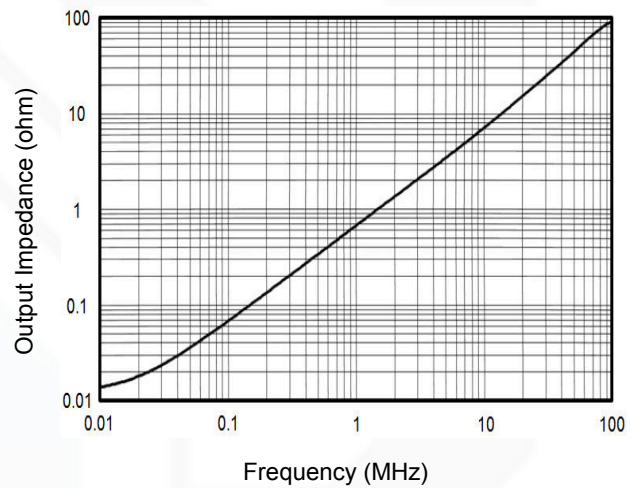
Overload Recovery Time



Large-Signal Disable/Enable Response



Closed-Loop Output Impedance vs Frequency





## Application Note

### Driving Capacitive Loads

GS805X series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the GS805X series packages save space on printed circuit boards and enable the design of smaller electronic products.

### Power Supply Bypassing and Board Layout

GS805X series operates from a single 2.5V to 5.5V supply or dual  $\pm 1.25\text{V}$  to  $\pm 2.75\text{V}$  supplies. For best performance, a  $0.1\mu\text{F}$  ceramic capacitor should be placed close to the  $V_{\text{DD}}$  pin in single supply operation. For dual supply operation, both  $V_{\text{DD}}$  and  $V_{\text{SS}}$  supplies should be bypassed to ground with separate  $0.1\mu\text{F}$  ceramic capacitors.

### Low Supply Current

The low supply current (typical 2.8mA per channel) of GS805X series will help to maximize battery life. They are ideal for battery powered systems

### Operating Voltage

GS805X series operate under wide input supply voltage (2.5V to 5.5V). In addition, all temperature specifications apply from  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ . Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime

### Rail-to-Rail Output

Rail-to-Rail output swing provides maximum possible dynamic range at the output. This is particularly important when operating in low supply voltages. The output voltage of GS805X series can typically swing to less than 8mV from supply rail in light resistive loads ( $>1\text{k}\Omega$ ), and 30mV of supply rail in moderate resistive loads ( $150\Omega$ ).

### Capacitive Load Tolerance

The GS805X family is optimized for bandwidth and speed, not for driving capacitive loads. Output capacitance will create a pole in the amplifier's feedback path, leading to excessive peaking and potential oscillation. If dealing with load capacitance is a requirement of the application, the two strategies to consider are (1) using a small resistor in series with the amplifier's output and the load capacitance and (2) reducing the bandwidth of the amplifier's feedback loop by increasing the overall noise gain. Figure 2. shows a unity gain follower using the series resistor strategy. The resistor isolates the output from the capacitance and, more importantly, creates a zero in the feedback path that compensates for the pole created by the output capacitance.

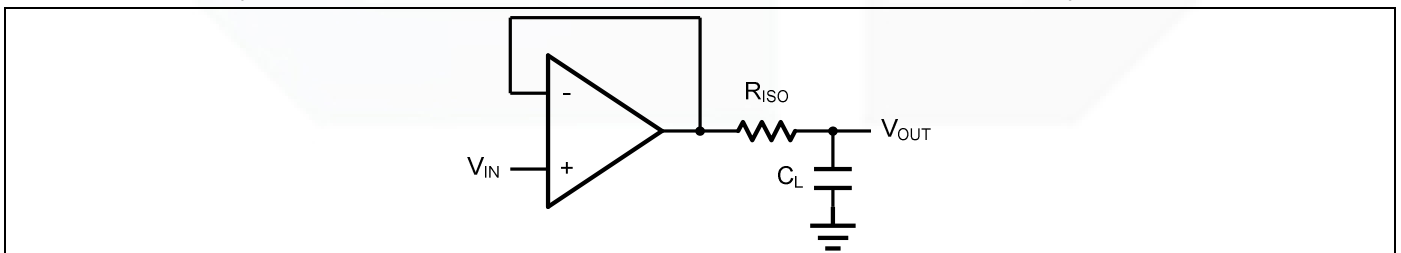


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the  $R_{\text{ISO}}$  resistor value, the more stable  $V_{\text{OUT}}$  will be. However, if there is a resistive load  $R_{\text{L}}$  in parallel with the capacitive load, a voltage divider (proportional to  $R_{\text{ISO}}/R_{\text{L}}$ ) is formed, this will result in a gain error.

The circuit in Figure 3 is an improvement to the one in Figure 2.  $R_F$  provides the DC accuracy by feed-forward the  $V_{IN}$  to  $R_L$ .  $C_F$  and  $R_{ISO}$  serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving the phase margin in the overall feedback loop. Capacitive drive can be increased by increasing the value of  $C_F$ . This in turn will slow down the pulse response.

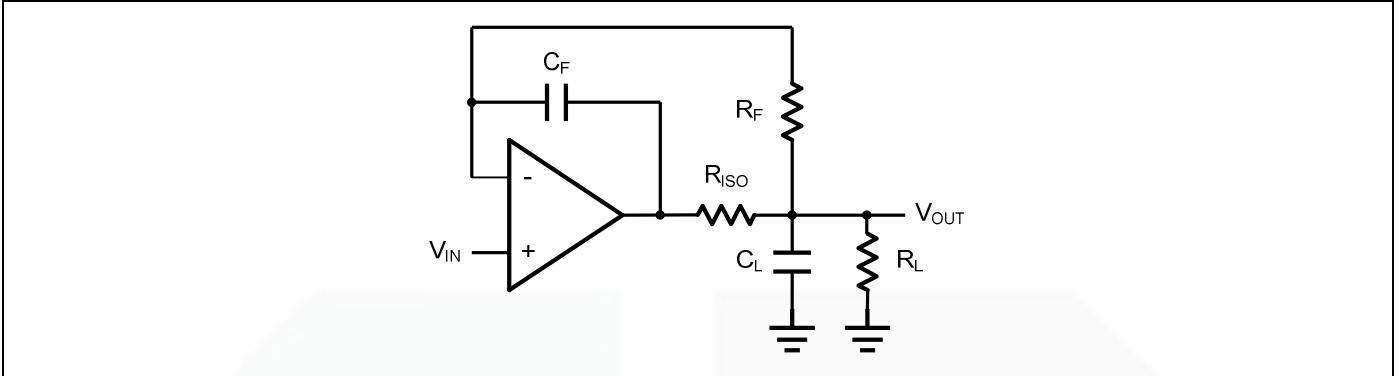


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

## 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 4. shows the differential amplifier using GS805X.

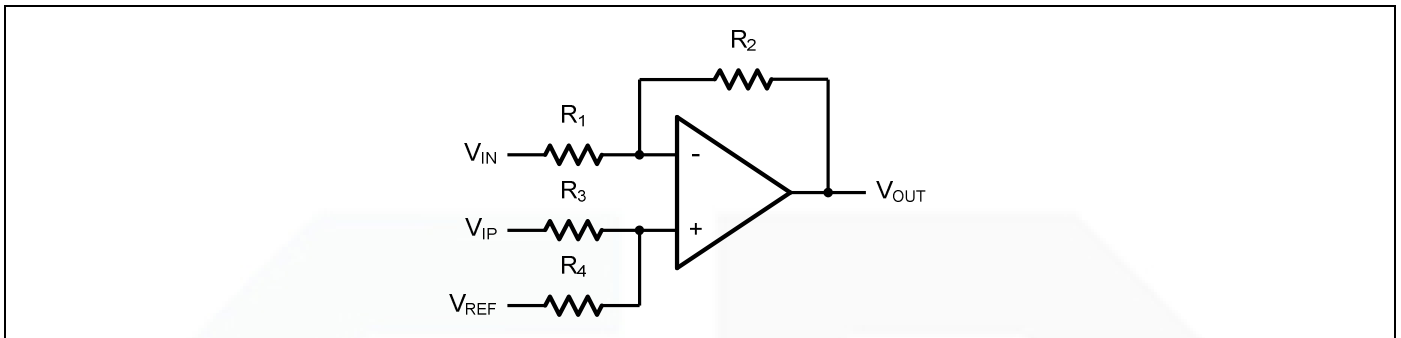


Figure 4. Differential Amplifier

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

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

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

### Low Pass Active Filter

The low pass active filter is shown in Figure 5. The DC gain is defined by  $-R_2/R_1$ . The filter has a -20dB/decade roll-off after its corner frequency  $f_c = 1/(2\pi R_3 C_1)$ .

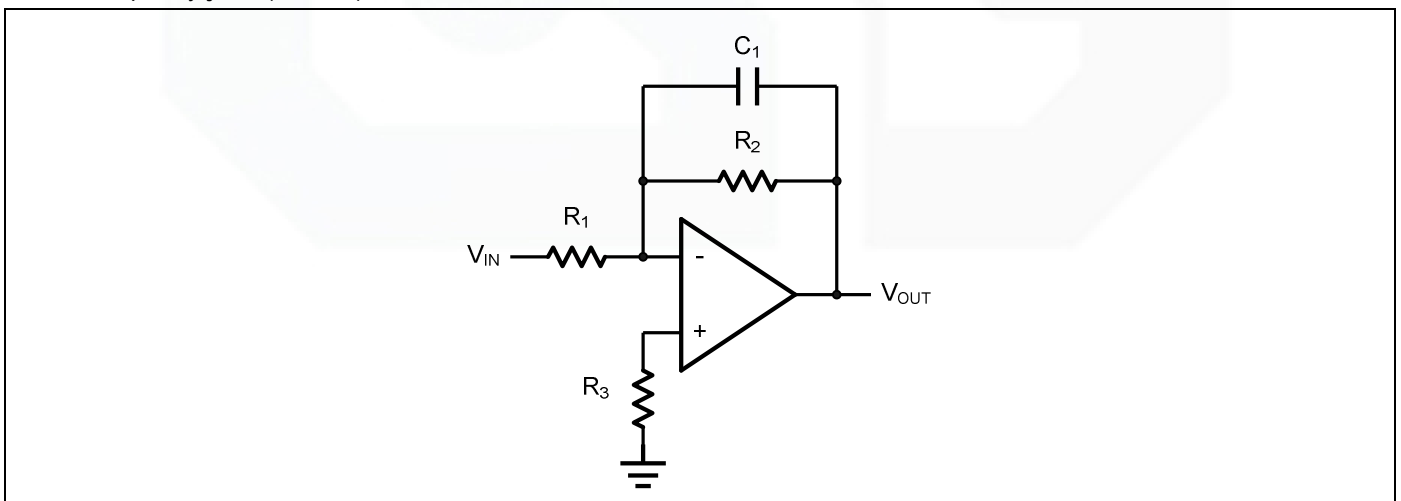


Figure 5. Low Pass Active Filter

**Driving Video**

The GS805x can be used in video applications like in Figure 6.

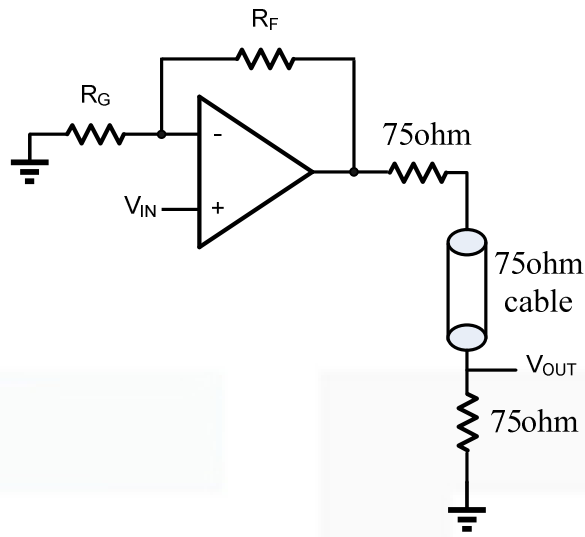
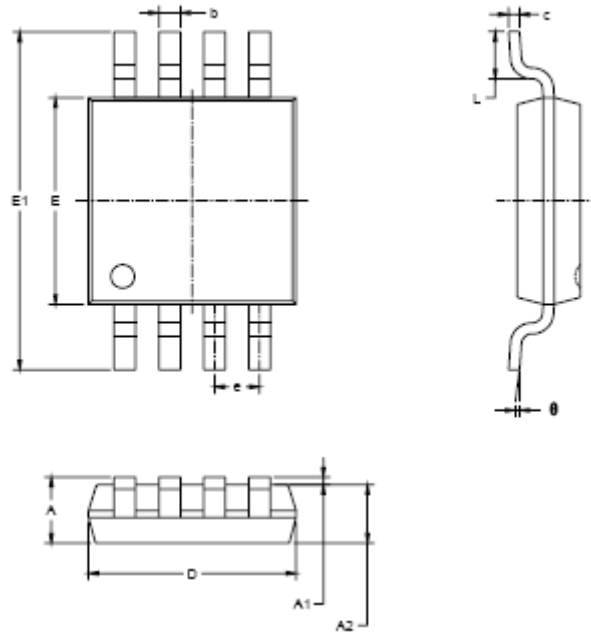
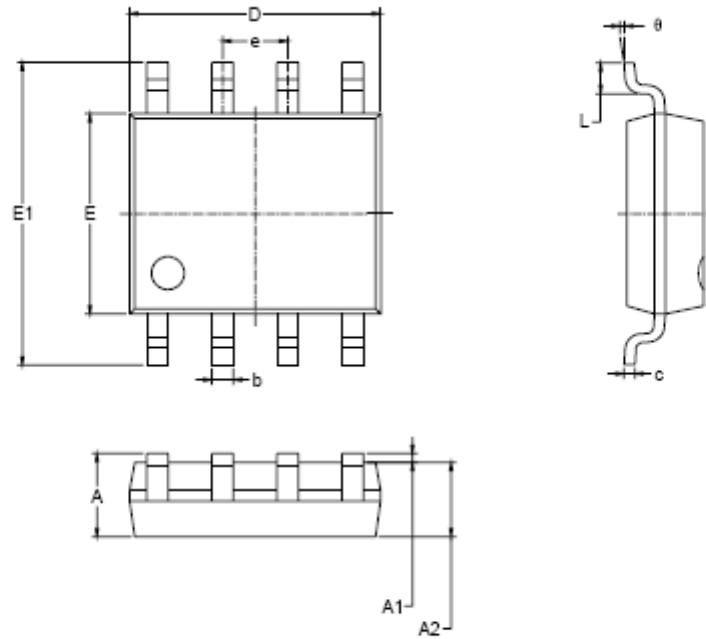


Figure 6. Typical video driving

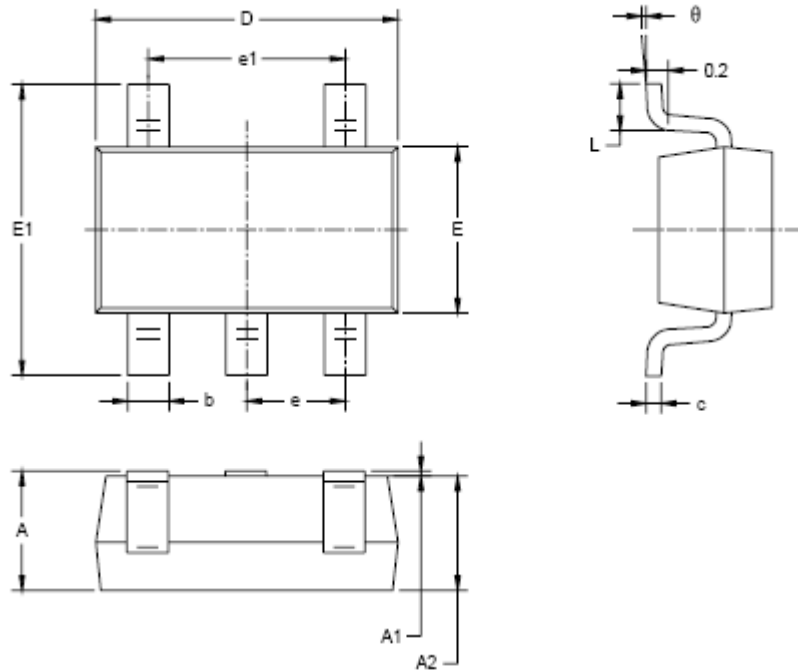
**Package Information**
**MSOP-8**


| 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                   | 0.008 |
| 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°    |

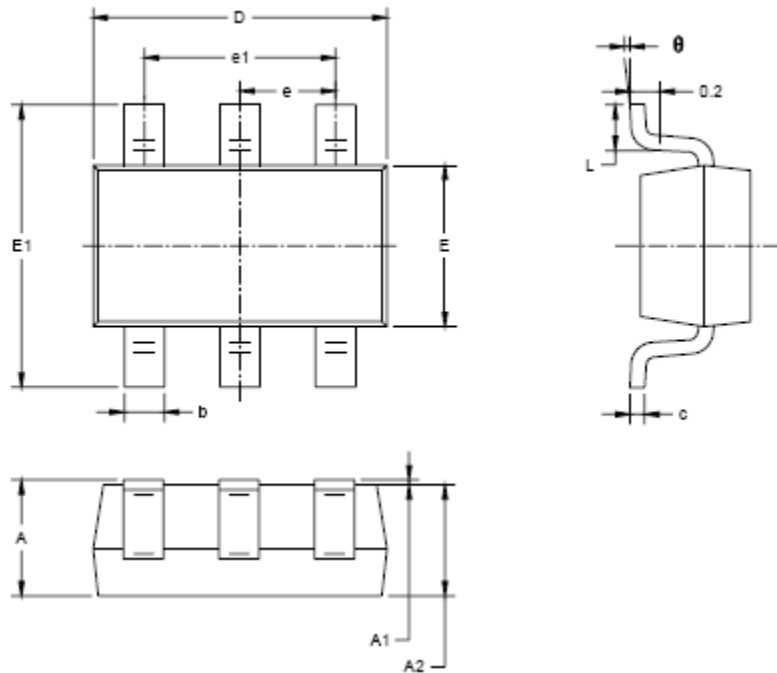
**SOP-8**


| 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°    |

## SOT23-5



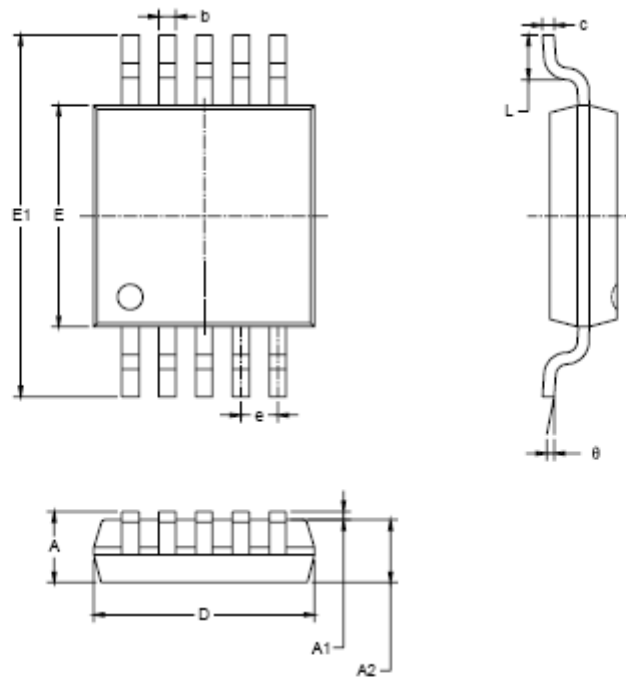
| Symbol   | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|----------|------------------------------|-------|-------------------------|-------|
|          | MIN                          | MAX   | MIN                     | MAX   |
| A        | 1.050                        | 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                   | 0.118 |
| 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°    |

**SOT23-6**


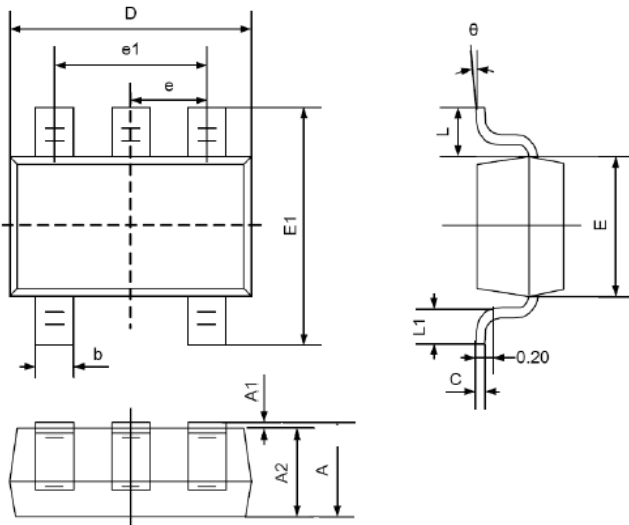
| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 1.050                        | 1.250 | 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     | 2.850                        | 2.950 | 0.104                   | 0.116 |
| e      | 0.950 BSC                    |       | 0.037 BSC               |       |
| e1     | 1.900 BSC                    |       | 0.075 BSC               |       |
| L      | 0.300                        | 0.800 | 0.012                   | 0.024 |
| θ      | 0°                           | 8°    | 0°                      | 8°    |



## MSOP-10

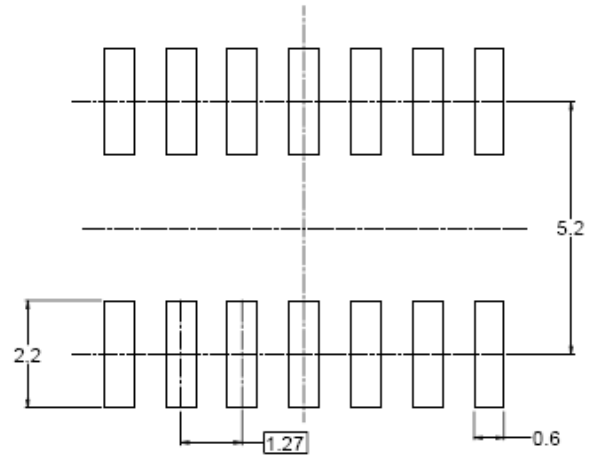
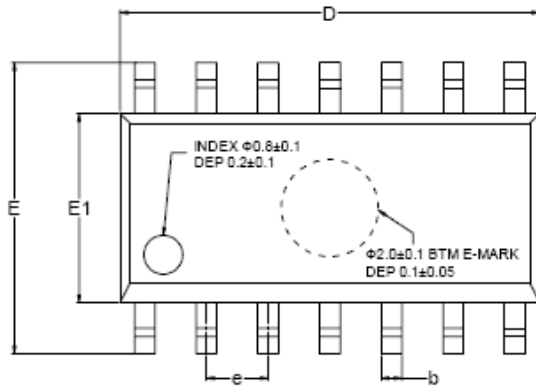


| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 0.820                        | 1.100 | 0.032                   | 0.043 |
| A1     | 0.020                        | 0.150 | 0.001                   | 0.006 |
| A2     | 0.750                        | 0.950 | 0.030                   | 0.037 |
| b      | 0.180                        | 0.280 | 0.007                   | 0.011 |
| 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      | 0.500 BSC                    |       | 0.020 BSC               |       |
| L      | 0.400                        | 0.800 | 0.016                   | 0.031 |
| θ      | 0°                           | 6°    | 0°                      | 6°    |

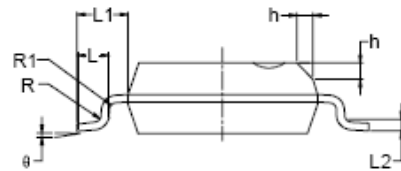
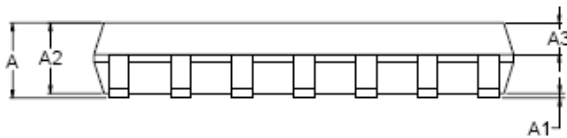
**SC70-5**


| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | Min                          | Max   | Min                     | Max   |
| A      | 0.900                        | 1.100 | 0.035                   | 0.043 |
| A1     | 0.000                        | 0.100 | 0.000                   | 0.004 |
| A2     | 0.900                        | 1.000 | 0.035                   | 0.039 |
| b      | 0.150                        | 0.350 | 0.006                   | 0.014 |
| C      | 0.080                        | 0.150 | 0.003                   | 0.006 |
| D      | 2.000                        | 2.200 | 0.079                   | 0.087 |
| E      | 1.150                        | 1.350 | 0.045                   | 0.053 |
| E1     | 2.150                        | 2.450 | 0.085                   | 0.096 |
| e      | 0.650TYP                     |       | 0.026TYP                |       |
| e1     | 1.200                        | 1.400 | 0.047                   | 0.055 |
| L      | 0.525REF                     |       | 0.021REF                |       |
| L1     | 0.260                        | 0.460 | 0.010                   | 0.018 |
| θ      | 0°                           | 8°    | 0°                      | 8°    |

## SOP-14

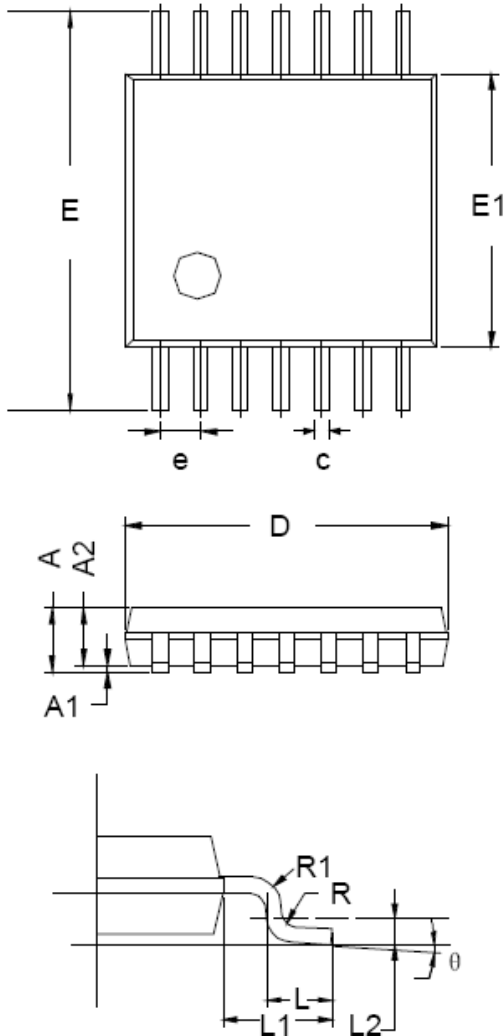


RECOMMENDED LAND PATTERN (Unit: mm)



| 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<br>In Millimeters |      |      |
|----------|------------------------------|------|------|
|          | MIN                          | TYP  | MAX  |
| A        | -                            | -    | 1.20 |
| A1       | 0.05                         | -    | 0.15 |
| A2       | 0.90                         | 1.00 | 1.05 |
| b        | 0.20                         | -    | 0.28 |
| c        | 0.10                         | -    | 0.19 |
| D        | 4.86                         | 4.96 | 5.06 |
| E        | 6.20                         | 6.40 | 6.60 |
| E1       | 4.30                         | 4.40 | 4.50 |
| e        | 0.65 BSC                     |      |      |
| L        | 0.45                         | 0.60 | 0.75 |
| L1       | 1.00 REF                     |      |      |
| L2       | 0.25 BSC                     |      |      |
| R        | 0.09                         | -    | -    |
| $\theta$ | 0°                           | -    | 8°   |