GS8091/8092/8094/8091N/8092N
350MHZ CMOS Rail-to-Rail Output Opamps

Features

- Single-Supply Operation from +2.5V ~ +5.5V
- Rail-to-Rail Output
- -3dB Bandwidth(G=+1): 350MHz (Typ.)
- Low Input Bias Current: 1pA (Typ.)
- Quiescent Current: 4.2mA/Amplifier (Typ.)
- Operating Temperature: -40°C ~ +125°C
- Small Package:

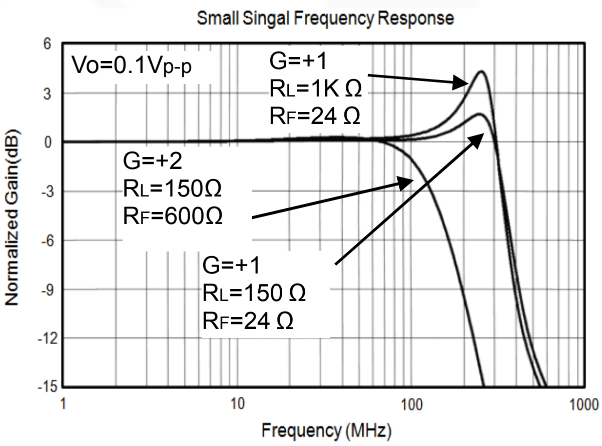
GS8091 Available in SOT23-5 and SC70-5 Packages
GS8092 Available in SOP-8 and MSOP-8 Packages
GS8094 Available in SOP-14 and TSSOP-14 Packages
GS8091N Available in SOT23-6 and SC70-6 Packages
GS8092N Available in MSOP-10 Packages

General Description

The GS8091/1N(single), GS8092/2N(dual), GS8094(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 GS8091 series provide excellent overall performance. They offer wide bandwidth to 350MHz (G = +1) along with 0.1dB flatness out to 58MHz (G = +2) and offer a typical low power of 4.2mA/amplifier.
The GS8091 series is low distortion and fast settling make it ideal for buffering high speed A/D or D/A converters. The GS8091/2N has a power-down disable feature that reduces the supply current to 75μA. These features make the GS8091/2N ideal for portable and battery-powered applications where size and power are critical. All are specified over the extended -40℃ to +125℃ temperature range.

Applications

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



Pin Configuration

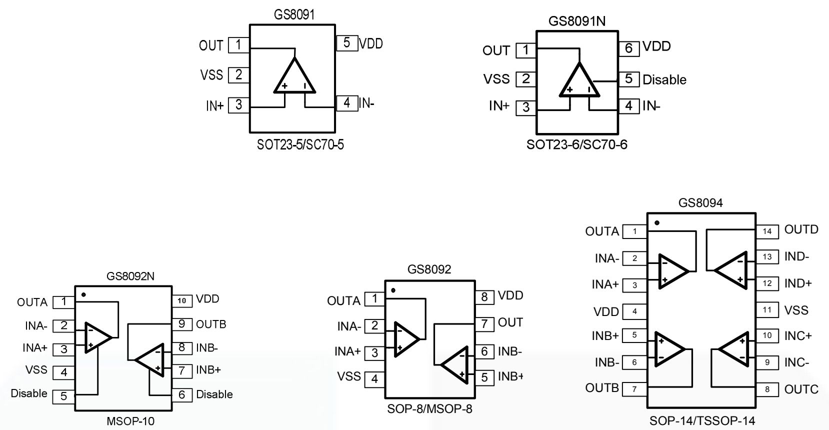


Figure 1. Pin Assignment Diagram

Absolute Maximum Ratings

Condition	Min	Max
Power Supply Voltage (V_{DD} to Vss)	-0.5V	+7.5V
Analog Input Voltage (IN+ or IN-)	Vss-0.5V	V_{DD}+0.5V
PDB Input Voltage	Vss-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	
Package Thermal Resistance (T_A=+25℃)		
SOP-8, θ_{JA}	125°C/W	
MSOP-8, θ_{JA}	216°C/W	
SOT23-5, θ_{JA}	190°C/W	
SOT23-6, θ_{JA}	190°C/W	
SC70-5, θ_{JA}	333°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.

Package/Ordering Information

MODEL	CHANNEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
GS8091	Single	GS8091-CR	SC70-5	Tape and Reel,3000	8091
		GS8091-TR	SOT23-5	Tape and Reel,3000	8091
GS8092	Dual	GS8092-SR	SOP-8	Tape and Reel,4000	GS8092
		GS8092-MR	MSOP-8	Tape and Reel,3000	GS8092
GS8094	Quad	GS8094-TR	TSSOP-14	Tape and Reel,3000	GS8094
		GS8094-SR	SOP-14	Tape and Reel,2500	GS8094
GS8091N	Single With shutdown	GS8091N-CR	SC70-6	Tape and Reel,3000	8091N
		GS8091N-TR	SOT23-6	Tape and Reel,3000	8091N
GS8092N	Dual With shutdown	GS8092N-MR	MSOP-10	Tape and Reel,2500	GS8092N

Electrical Performance Characteristics

(G= +2, R_F=600Ω, R_G=600Ω, and R_L=150Ω connected to V_S/2, unless otherwise noted. Typical values are at T_A =+25°C.)

PARAMETER	CONDITIONS	GS8091/52/54/51N/52N						
		TYP	MIN/MAX OVER TEMPERATURE					
		+25℃	+25℃	0℃ to70℃	-40℃to 85℃	-40℃ to125℃	UNITS	MIN/ MAX
DYNAMIC PERFORMANCE								
-3dB Small Signal Bandwidth	G = +1, Vo = 0.1V p-p, R_F = 24Ω, R_L = 150Ω	335					MHz	TYP
	G = +1, Vo = 0.1V p-p, R_F = 24Ω, R_L = 1kΩ	330					MHz	TYP
	G = +2, Vo = 0.1V p-p, R_L = 50Ω	79					MHz	TYP
	G = +2, Vo = 0.1V p-p, R_L = 150Ω	130					MHz	TYP
	G = +2, Vo = 0.1V p-p, R_L = 1kΩ	165					MHz	TYP
	G = +2, Vo = 0.1V p-p, R_L = 10kΩ	172					MHz	TYP
Gain-Bandwidth Product	G = +10, R_L = 150Ω	180					MHz	TYP
	G = +10, R_L = 1kΩ	195					MHz	TYP
Bandwidth for 0.1dB Flatness	G = +2, Vo = 0.1V $_{p-p}$, R_L = 150Ω, R_F =600Ω	71					MHz	TYP
Slew Rate	G = +1, 2V Output Step	119/-232					V/μs	TYP
	G = +2, 2V Output Step	135/-180					V/μs	TYP
	G = +2, 4V Output Step	142/-206					V/μs	TYP
Rise-and-Fall Time	G = +2, Vo = $0.2V_{p-p}$, 10% to 90%	3.5					ns	TYP
	G = +2, Vo = $2V_{p-p}$, 10% to 90%	8.5					ns	TYP
Settling Time to 0.1%	G = +2, 2V Output Step	35					ns	TYP
Overload Recovery Time	V_{IN} • G = +VS	14.5					ns	TYP
NOISE/DISTORTION PERFORMANCE								
Input Voltage Noise	f = 1MHz	4.3					nV/ Hz	TYP
Differential Gain Error (NTSC)	G = +2, R_L = 150Ω	0.004					%	TYP
Differential Phase Error (NTSC)	G = +2, R_L = 150Ω	0.08					degree	TYP
DC PERFORMANCE								
Input Offset Voltage (V_{OS})		±2	±8	±8.5	±9	±9.3	mV	MAX
Input Offset Voltage Drift		2					μV/℃	TYP
Input Bias Current (I_B)		1					PA	TYP
Input offset Current (I_{OS})		2					PA	TYP
Open-Loop Gain (A_{OL})	V_O = 0.3V to 4.7V, R_L = 150Ω	80	75	74	74	70	dB	MIN
	V_O = 0.2V to 4.8V, R_L = 1kΩ	104	92	91	91	80	dB	MIN
INPUT CHARACTERISTICS								
Input Common-Mode Voltage Range (V_{CM})		-0.2 to +3.8					V	TYP
Common-Mode Rejection Ratio (CMRR)	V_{CM} = -0.1V to +3.5V	80	66	65	65	62	dB	MIN

Electrical Performance Characteristics

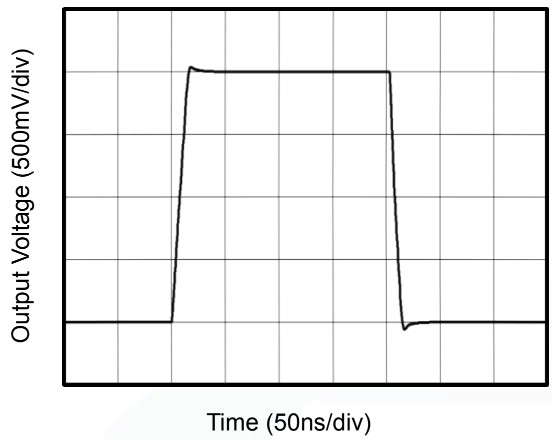
(G= +2, R_F=600Ω, R_G=600Ω, and R_L=150Ω connected to V_S/2, unless otherwise noted. Typical values are at T_A =+25°C.)

PARAMETER	CONDITIONS	GS8091/52/54/51N/52N						
		TYP	MIN/MAX OVER TEMPERATURE					
		+25℃	+25℃	0℃ to70℃	-40℃to 85℃	-40℃ to125℃	UNITS	MIN/ MAX
OUTPUT CHARACTERISTICS								
Output Voltage Swing from Rail	R_L = 150Ω	0.12					V	TYP
	R_L = 1kΩ	0.03					V	TYP
Output Current		120	100	98	93	87	mA	MIN
Closed-Loop Output Impedance	f<100kHz	0.045					Ω	TYP
POWER-DOWN DISABLE (GS8091/2N only)								
Turn-On Time		108					ns	TYP
Turn-Off Time		60					ns	TYP
DISABLE Voltage-Off			0.8				V	MAX
DISABLE Voltage-On			2				V	MIN
POWER SUPPLY								
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)		4.2	5.3	5.6	5.7	6.1	mA	MAX
Supply Current when Disabled per amplifier(GS8091/2N only)		75	120	130	132	137	μA	MAX
Power Supply Rejection Ratio (PSRR)	ΔV_S = +2.7V to +5.5V, V_{CM} = $(-V_S)$ +0.5	80	67	67	65	62	dB	MIN

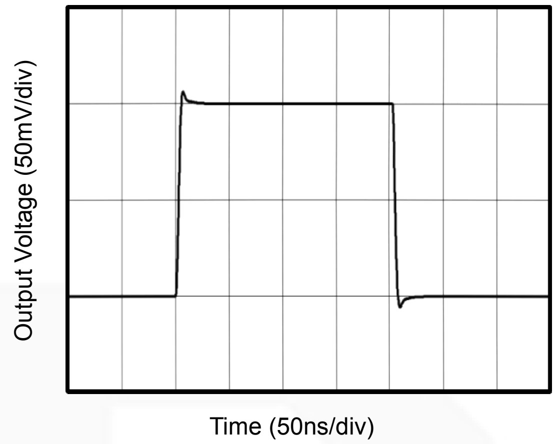
Typical Performance characteristics

(Vs=+5V,G= +2, R_F=600Ω,R_G=600Ω,and R_L=150Ω connected to Vs/2, unless otherwise noted. Typical values are at T_A =+25°C.)

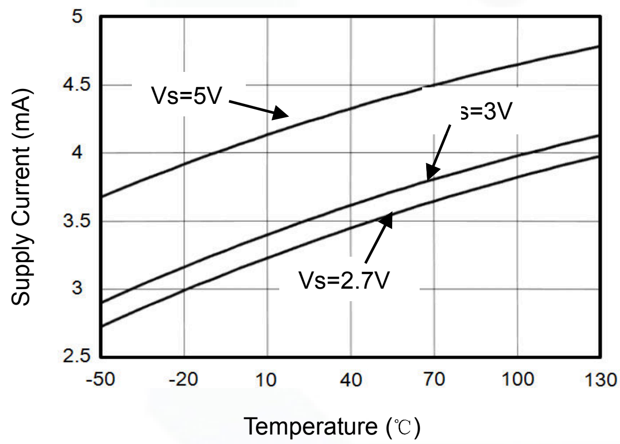
Non-Inverting Large-Signal Step Response



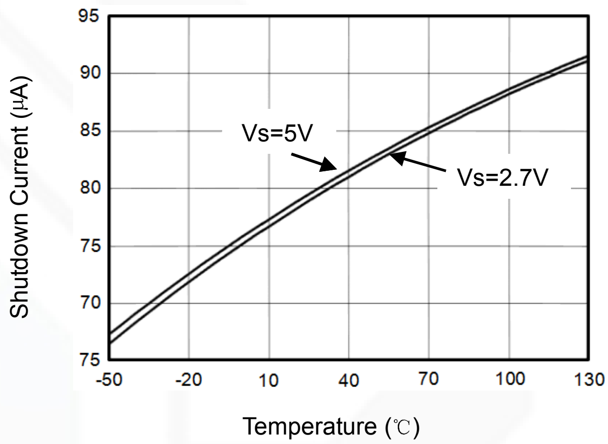
Non-Inverting Small-Signal Step Response



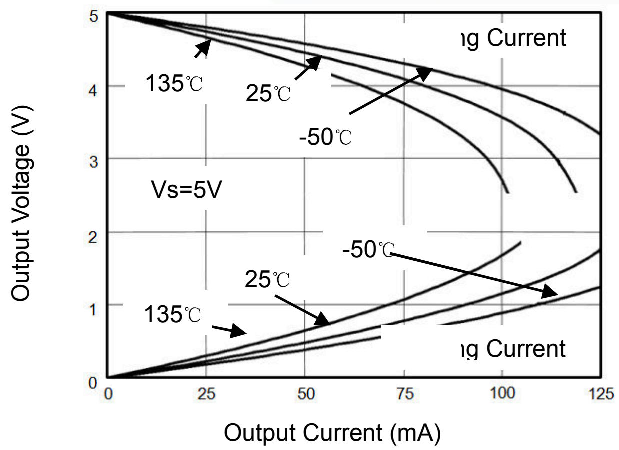
Supply Current vs. Temperature



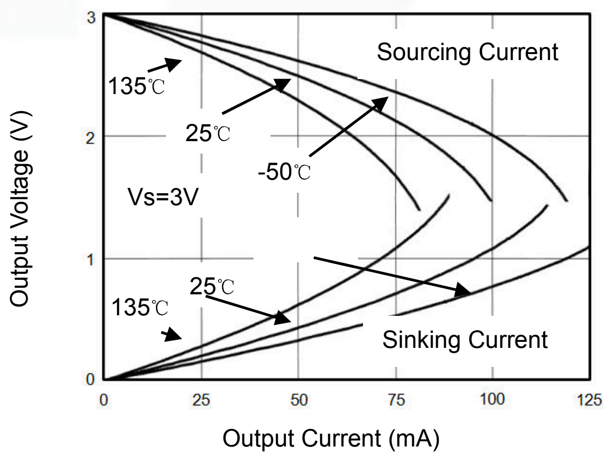
Sutdown Current vs. Temperature



Output Voltage Swing vs. Output Current



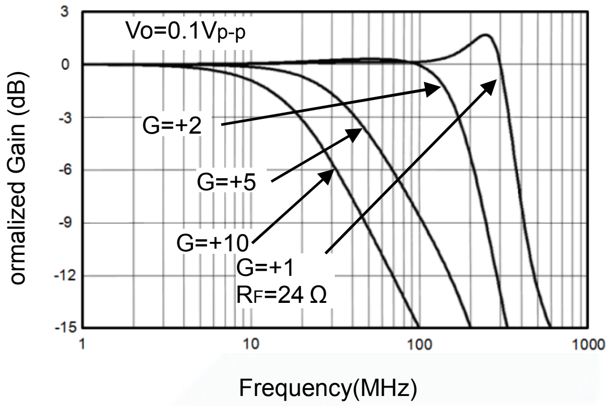
Output Voltage vs. Output Current



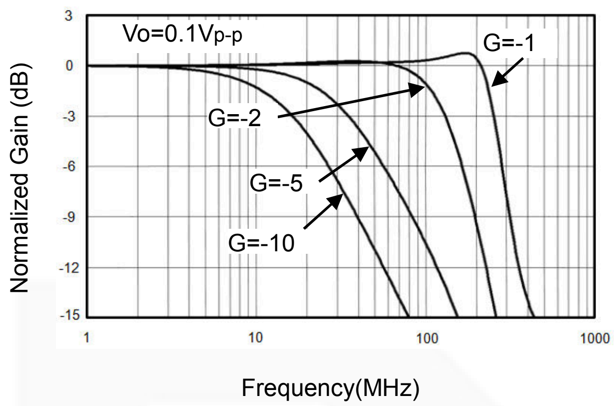
Typical Performance characteristics

(Vs=+5V,G= +2, R_F=600Ω,R_G=600Ω,and R_L=150Ω connected to Vs/2, unless otherwise noted. Typical values are at T_A =+25°C.)

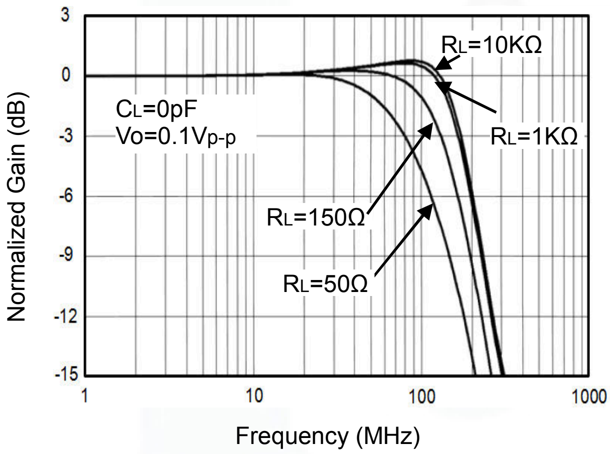
Non-Inverting Small Signal Frequency Response



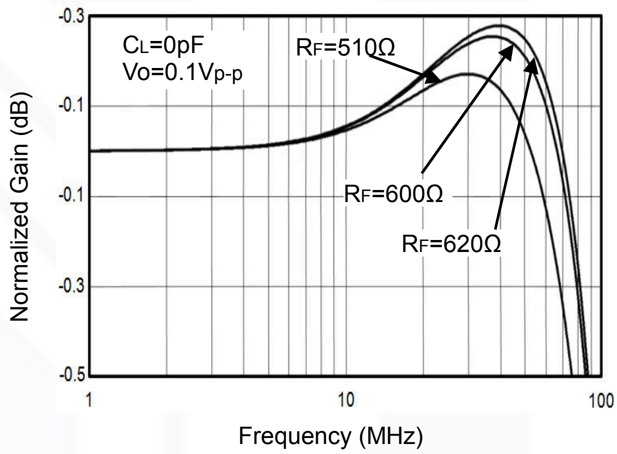
Inverting Small Signal Frequency Response



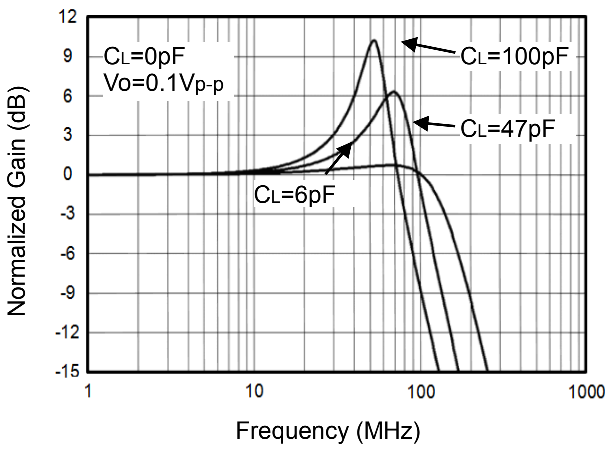
Frequency Response For Various RL



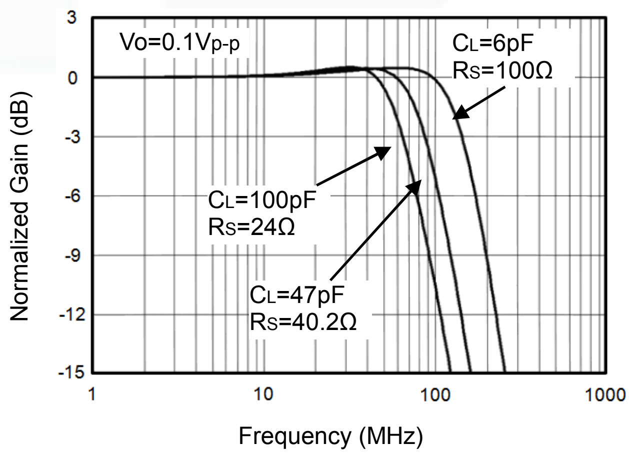
0.1dB Gain Flatness For Various RF



Frequency Response For Various CL



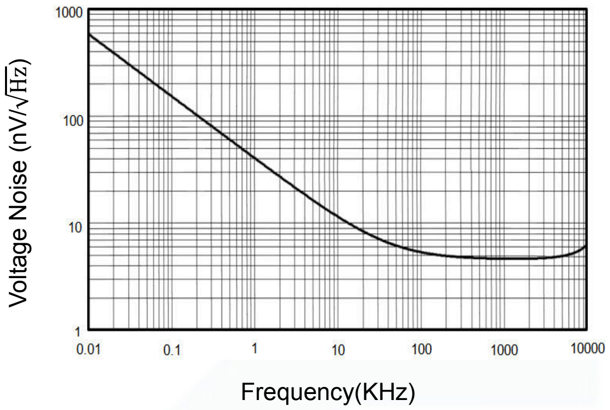
Frequency Response vs.Capacitive Load



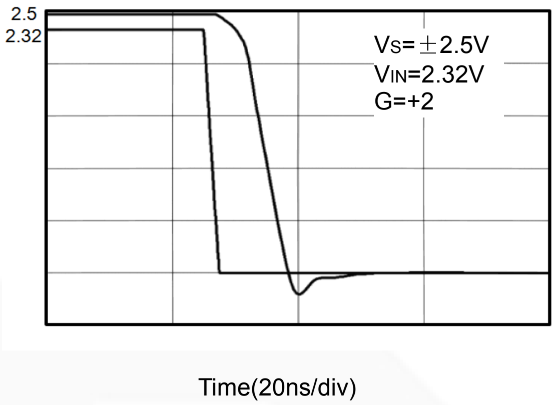
Typical Performance characteristics

(Vs=+5V,G= +2, R_F=600Ω,R_G=600Ω,and R_L=150Ω connected to Vs/2, unless otherwise noted. Typical values are at T_A =+25°C.)

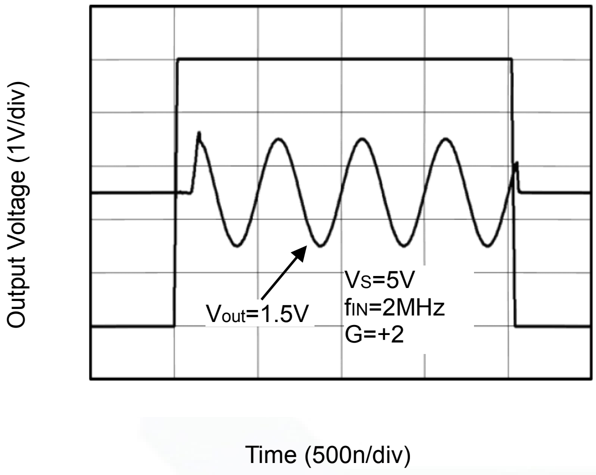
Input Voltage Noise Spectral Density vs. Frequency



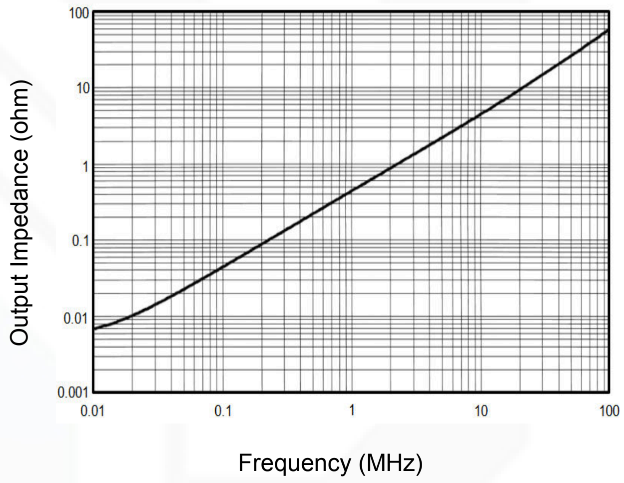
Overload Recovery Time



Large-Signal Disable/Enable Response



Closed-Loop Output Impedance vs Frequency



Application Note

Driving Capacitive Loads

GS809X series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the GS809X series packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

GS809X series operates from a single 2.5V to 5.5V supply or dual ±1.25V to ±2.75V supplies. For best performance, a 0.1μF ceramic capacitor should be placed close to the V_{DD} pin in single supply operation. For dual supply operation, both V_{DD} and V_{SS} supplies should be bypassed to ground with separate 0.1μF ceramic capacitors.

Low Supply Current

The low supply current (typical 4.2mA per channel) of GS809X series will help to maximize battery life. They are ideal for battery powered systems

Operating Voltage

GS809X series operate under wide input supply voltage (2.5V to 5.5V). In addition, all temperature specifications apply from -40 °C to +125 °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 GS809X series can typically swing to less than 30mV from supply rail in light resistive loads (>1kΩ), and 120mV of supply rail in moderate resistive loads (150Ω).

Capacitive Load Tolerance

The GS809X 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.

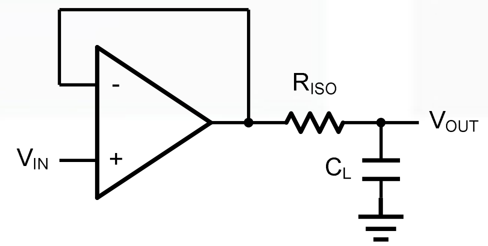


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the RISO resistor value, the more stable VOUT will be. However, if there is a resistive load RL in parallel with the capacitive load, a voltage divider (proportional to R_{ISO}/R_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.

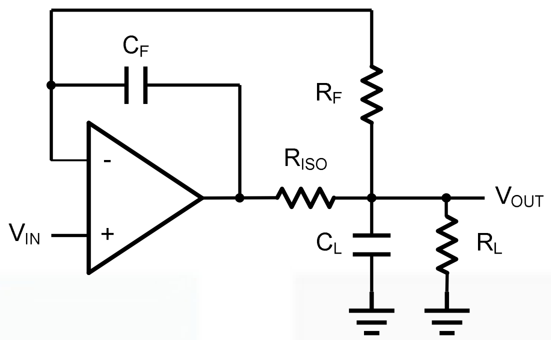


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

Typical Application Circuits

Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common 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. shown the differential amplifier using GS809X.

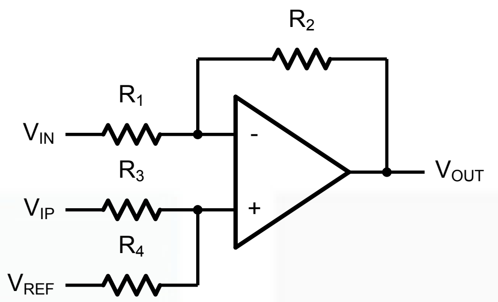


Figure 4. Differential Amplifier

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

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 $f_C=1/(2\pi R_3C_1)$.

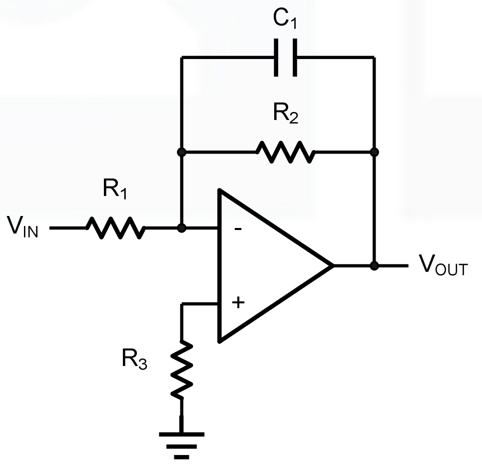


Figure 5. Low Pass Active Filter

Driving Video

The GS809X can be used in video applications like in Figure 6.

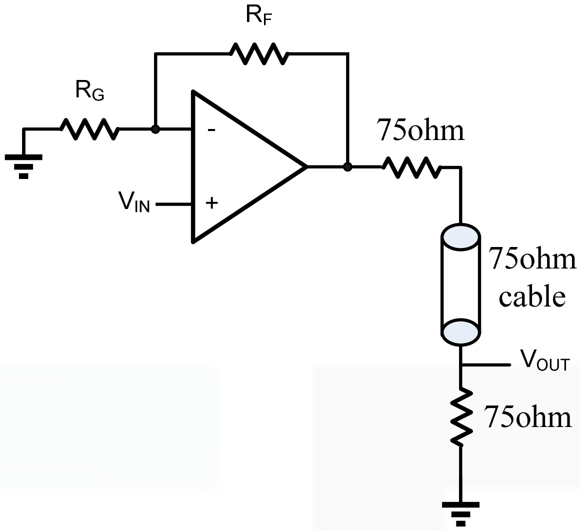
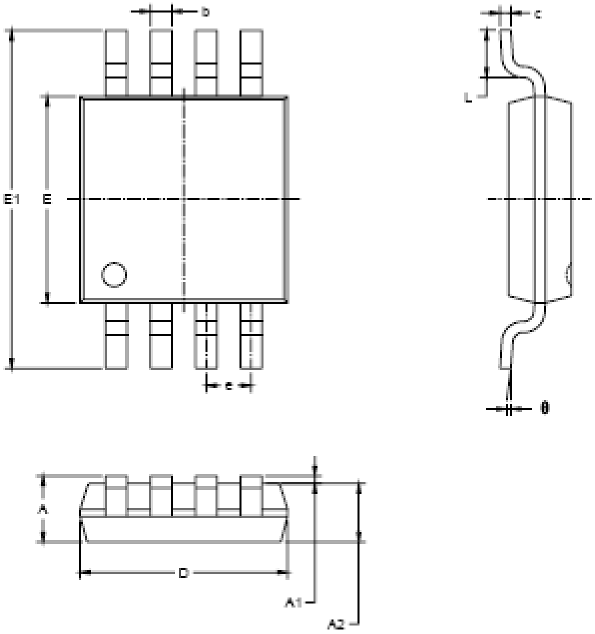


Figure 6. Typical video driving

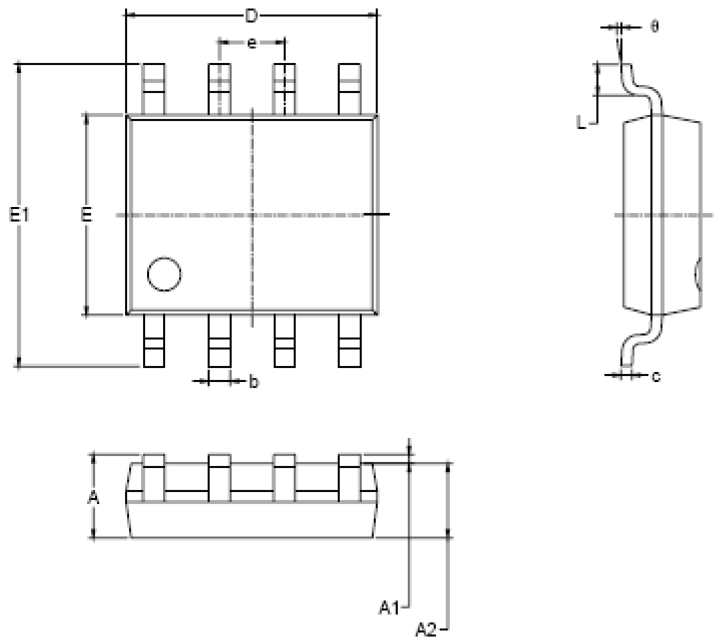
Package Information

MSOP8



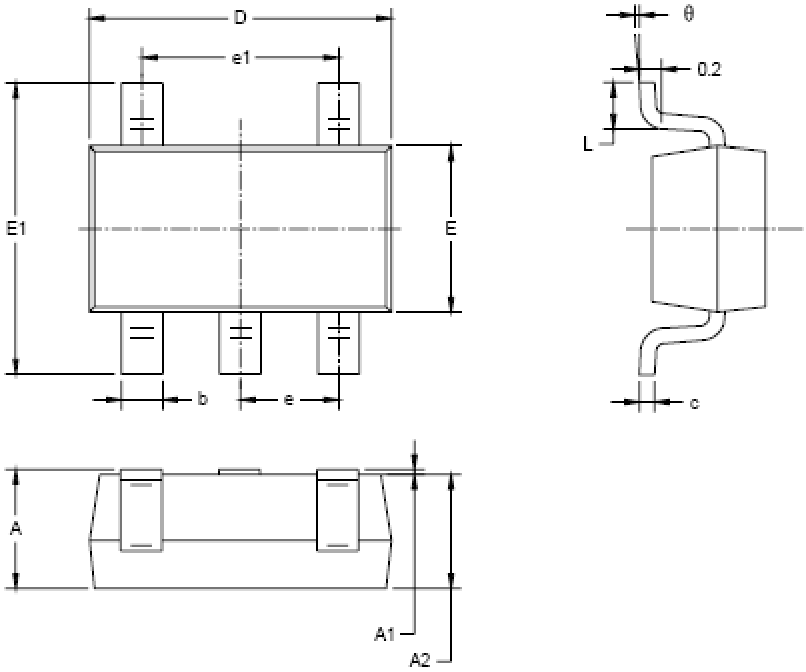
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

SOP8



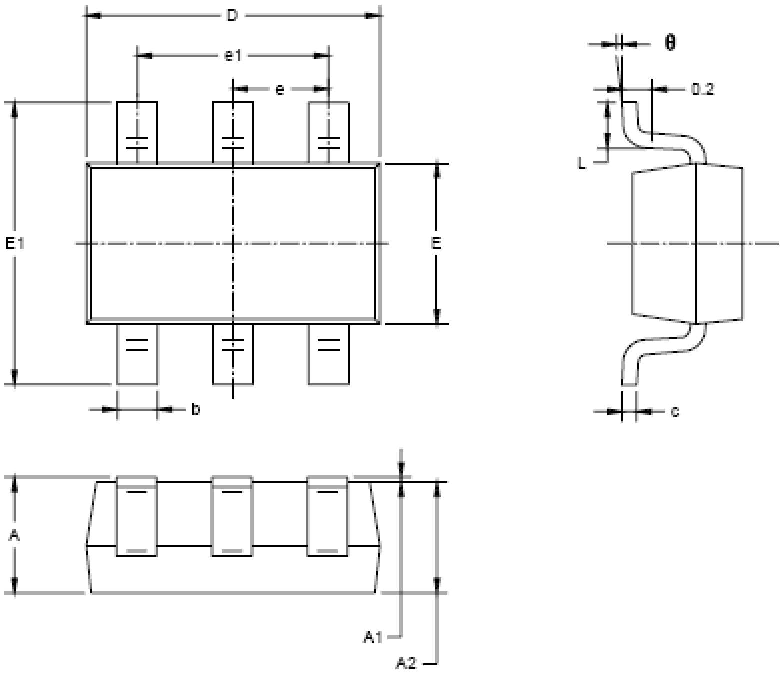
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

SOT23-5



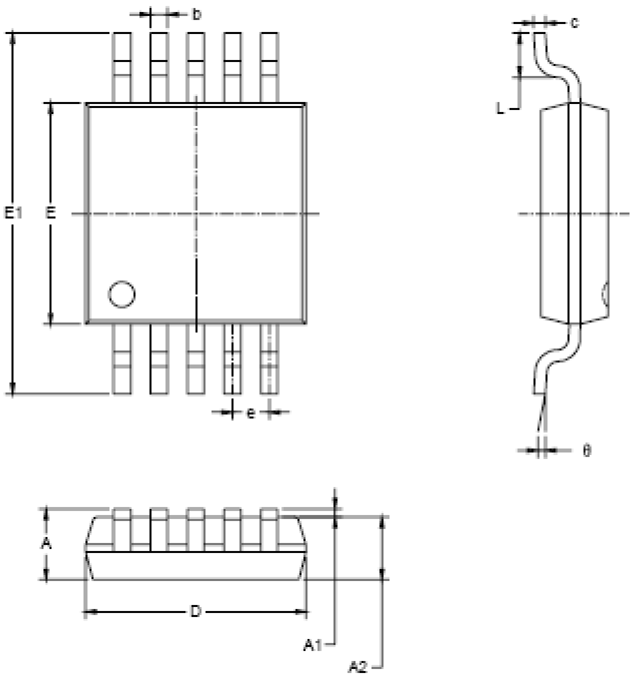
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

SOT23-6



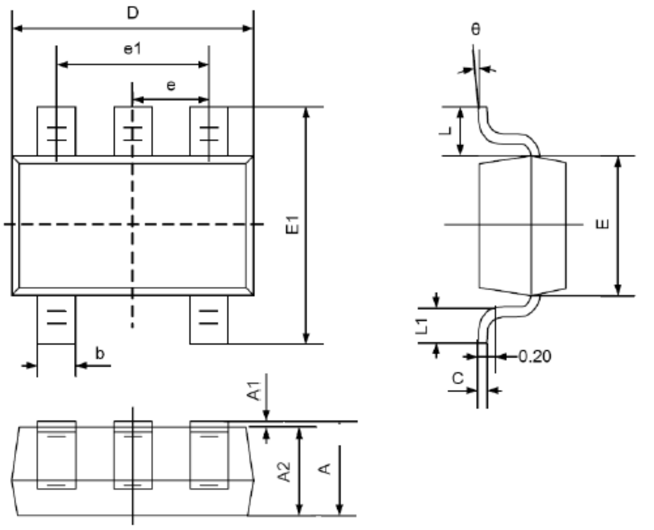
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

MSOP-10



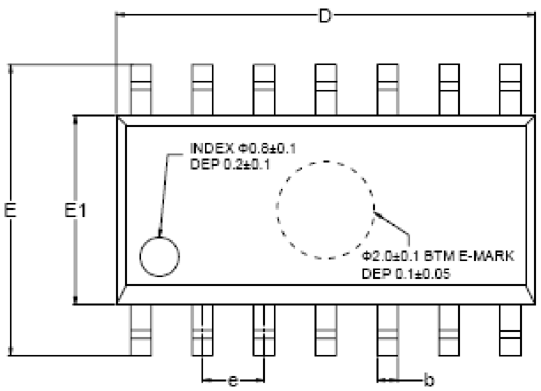
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.180	0.280	0.007	0.011
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.500 BSC		0.020 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

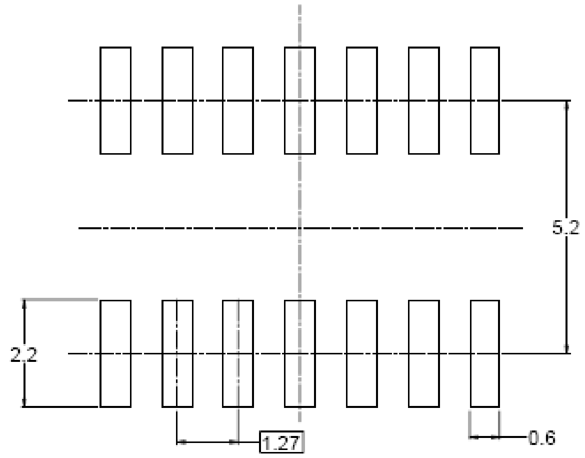
SC70-5



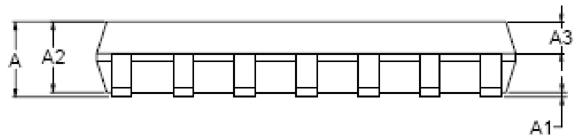
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650TYP		0.026TYP	
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°

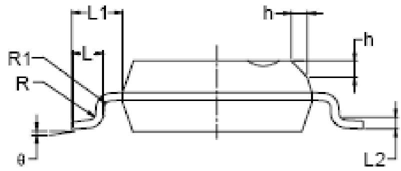
SOP-14





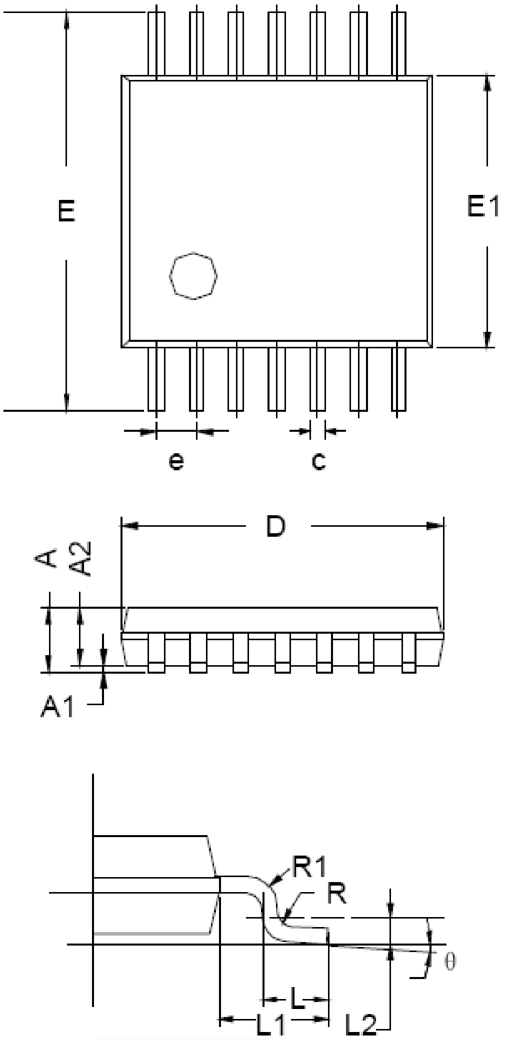
RECOMMENDED LAND PATTERN (Unit: mm)





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
θ	0°		8°	0°		8°

TSSOP-14



Symbol	Dimensions 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	-	-
θ	0°	-	8°