SGM8091/2/3/4
350MHz, Rail-to-Rail Output CMOS Operational Amplifiers

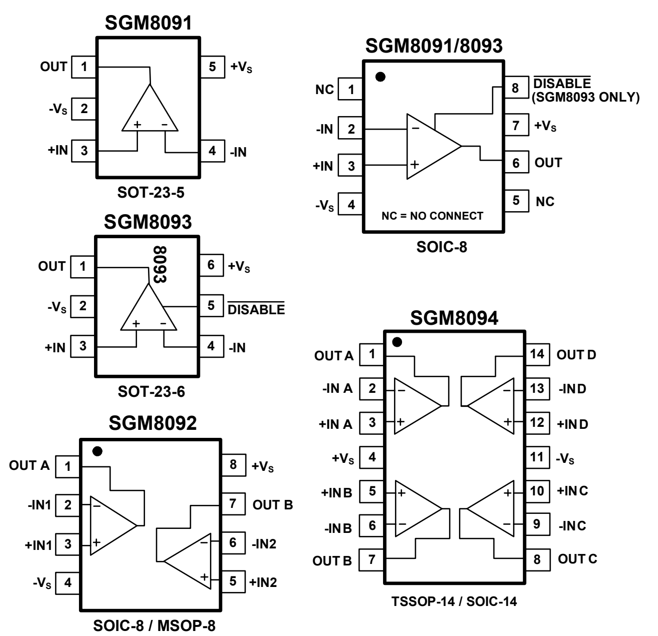
PRODUCT DESCRIPTION

The SGM8091/8093(single), SGM8092 (dual), SGM8094 (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 SGM8091 series provide excellent overall performance. They offer wide bandwidth to 350MHz (G = +1) along with 0.1 dB flatness out to 125MHz (G = +1) and offer a typical low power of 4.3mA/amplifier.

The SGM8091 series are low distortion and fast settling make them ideal for buffering high speed A/D or D/A converters. The SGM8093 has a power-down disable feature that reduces the supply current to 75μA. These features make the SGM8093 ideal for portable and battery-powered applications where size and power are critical. All are specified over the extended -40℃ to +125℃ temperature range.

PIN CONFIGURATIONS (Top View)

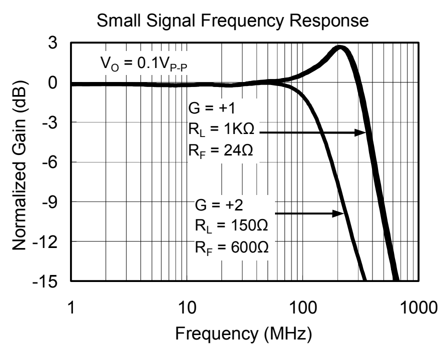


FEATURES

- **Rail-to-Rail Output**
  2mV Typical V_{OS}
- **High Speed**
  350MHz, -3dB Bandwidth (G = +1)
  265V/μs, Slew Rate
  32ns Settling Time to 0.1% with 2V Step
- **Operates on 2.5V to 5.5V Supplies**
- **Input Voltage Range = -0.2V to +3.8V with V_S = 5V**
- **Excellent Video Specs (R_L = 150Ω, G = +2)**
  Gain Flatness 0.1dB to 70MHz
  Diff Gain: 0.004%, Diff Phase: 0.08 degree
- **Low Power**
  4.3mA/Amplifier Typical Supply Current
  SGM8093 75μA when Disabled
- **Small Packaging**
  SGM8091 Available in SOIC-8 and SOT-23-5
  SGM8092 Available in SOIC-8 and MSOP-8
  SGM8093 Available in SOIC-8 and SOT-23-6
  SGM8094 Available in SOIC-14 and TSSOP-14

APPLICATIONS

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



PACKAGE/ORDERING INFORMATION

MODEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
SGM8091	SGM8091XN5/TR	SOT-23-5	Tape and Reel, 3000	8091
	SGM8091XS/TR	SOIC-8	Tape and Reel, 2500	SGM8091XS
SGM8092	SGM8092XS/TR	SOIC-8	Tape and Reel, 2500	SGM8092XS
	SGM8092XMS/TR	MSOP-8	Tape and Reel, 3000	SGM8092XMS
SGM8093	SGM8093XN6/TR	SOT-23-6	Tape and Reel, 3000	8093
	SGM8093XS/TR	SOIC-8	Tape and Reel, 2500	SGM8093XS
SGM8094	SGM8094XS14/TR	SOIC-14	Tape and Reel, 2500	SGM8094XS14
	SGM8094XTS14/TR	TSSOP-14	Tape and Reel, 3000	SGM8094XTS14

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V+ to V- 7.5V
Common-Mode Input Voltage........($-V_S$) - 0.5V to ($+V_S$) +0.5V
Storage Temperature Range ....-65℃ to +150℃
Junction Temperature .... 160℃
Operating Temperature Range ....-55℃ to +150℃
Package Thermal Resistance @ T_A = +25℃
SOT-23-5, θ_{JA}... 190℃/W
SOT-23-6, θ_{JA}... 190℃/W
SOIC-8, θ_{JA}...125℃/W
MSOP-8, θ_{JA}.. 216℃/W
Lead Temperature Range (Soldering 10 sec)................ 260℃
ESD Susceptibility
HBM..1000V
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.

SGMICRO reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time. Please contact SGMICRO sales office to get the last datasheet.

ELECTRICAL CHARACTERISTICS: V_S = +5V

(G=+2, R_F =600Ω, R_L = 150Ω, unless otherwise noted.)

PARAMETER	CONDITIONS	SGM8091/2/3/4 TYP +25℃	MIN/MAX OVER TEMPERATURE +25℃	0℃ to 70℃	-40℃ to 70℃	-40℃ to 125℃	UNITS	MIN/MAX
DYNAMIC PERFORMANCE								
-3dB Small Signal Bandwidth	G = +1, Vo = 0.1Vp-p, R_F = 24Ω, R_L = 150Ω	300					MHz	TYP
	G = +1, Vo = 0.1Vp-p, R_F = 24Ω, R_L = 1kΩ	350					MHz	TYP
	G = +2, Vo = 0.1Vp-p, R_L = 50Ω	70					MHz	TYP
	G = +2, Vo = 0.1Vp-p, R_L = 150Ω	140					MHz	TYP
	G = +2, Vo = 0.1Vp-p, R_L = 1kΩ	170					MHz	TYP
	G = +2, Vo = 0.1Vp-p, R_L = 10kΩ	230					MHz	TYP
Gain-Bandwidth Product	G = +10, R_L =150Ω	135					MHz	TYP
	G = +10, R_L =1kΩ	170					MHz	TYP
Bandwidth for 0.1dB Flatness	G = +1, Vo = 0.1Vp-p	125					MHz	TYP
	G = +2, Vo = 0.1Vp-p, R_F = 600Ω	70					MHz	TYP
Slew Rate	G = +1, 2V Output Step	194/-204					V/μs	TYP
	G = +2, 2V Output Step	236/-170					V/μs	TYP
	G = +2, 4V Output Step	265/-218					V/μs	TYP
Rise-and-Fall Time	G = +2, Vo = 0.2Vp-p, 10% to 90%	3.8					ns	TYP
	G = +2, Vo = 2Vp-p, 10% to 90%	7.8					ns	TYP
Settling Time to 0.1%	G = +2, 2V Output Step	32					ns	TYP
Overload Recovery Time	V_{IN} · G = $+V_S$	14.5					ns	TYP
NOISE/DISTORTION PERFORMANCE								
Input Voltage Noise	f = 1MHz	5.9					nV/$\sqrt{Hz}$	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	±8.9	±9.5	±9.8	mV	MAX
Input Offset Voltage Drift		3.7					μV/℃	TYP
Input Bias Current (I_B)		6					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	73	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	66	65	64	dB	MIN
OUTPUT CHARACTERISTICS								
Output Voltage Swing from Rail	R_L = 150Ω	0.12					V	TYP
	R_L = 1kΩ	0.03					V	TYP
Output Current		115	98	97	94	88	mA	MIN
Closed-Loop Output Impedance	f < 100kHz	0.02					Ω	TYP
POWER-DOWN DISABLE								
Turn-On Time		108					ns	TYP
Turn-Off Time		60					ns	TYP
$\overline{DISABLE}$ Voltage-Off			0.8				V	MAX
$\overline{DISABLE}$ 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)		4.3	7.5	8.0	8.0	8.1	mA	MAX
Supply Current when Disabled (SGM8093 only)		75	120	127	130	137	μA	MAX
Power Supply Rejection Ratio (PSRR)	ΔV_S = + 2.7V to + 5.5V, V_{CM} = $(-V_S)$ + 0.5	80	66	66	64	62	dB	MIN

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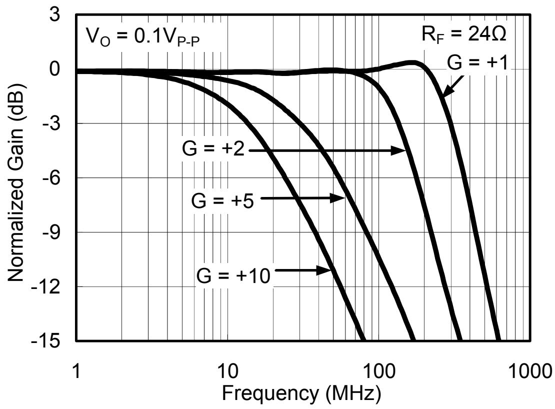
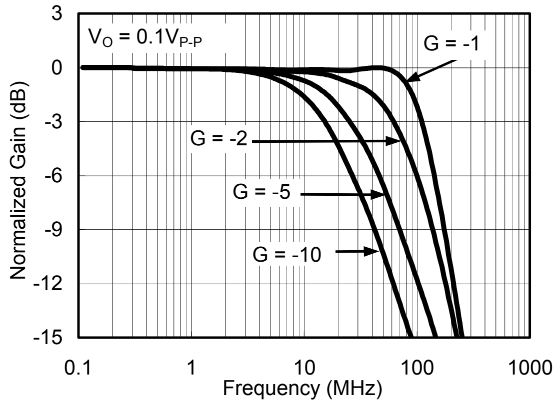
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25°C, V_S = +5V, G = +2, R_F = 600Ω, R_G = 600Ω, and R_L= 150Ω connected to Vs/2, unless otherwise noted.

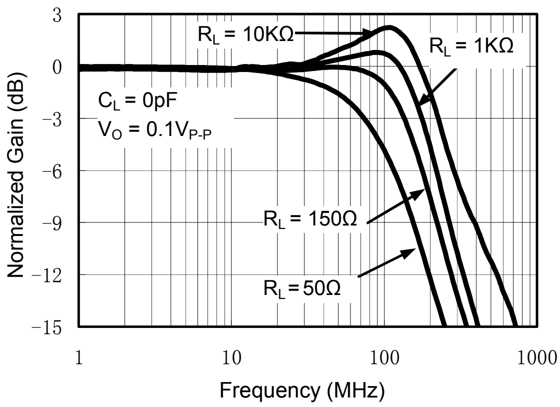
Non-Inverting Small Signal Frequency Response



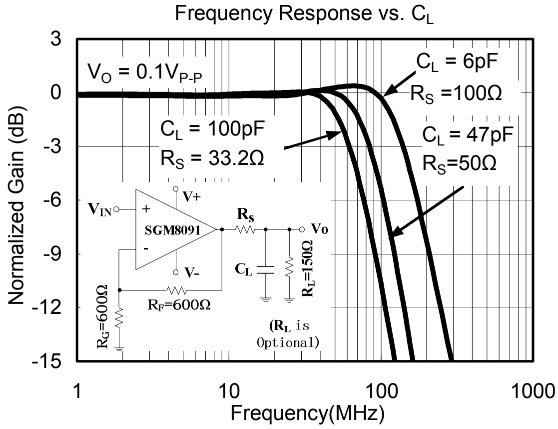
Inverting Small Signal Frequency Response



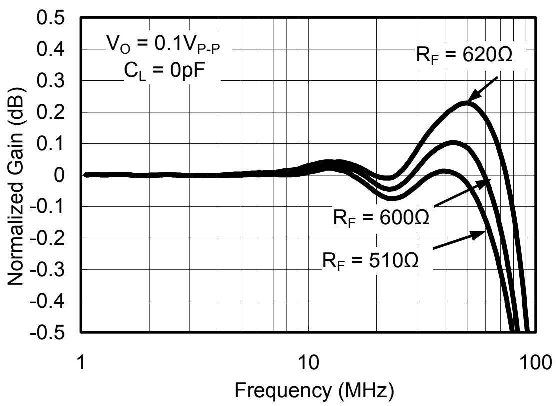
Frequency Response for Various R_L



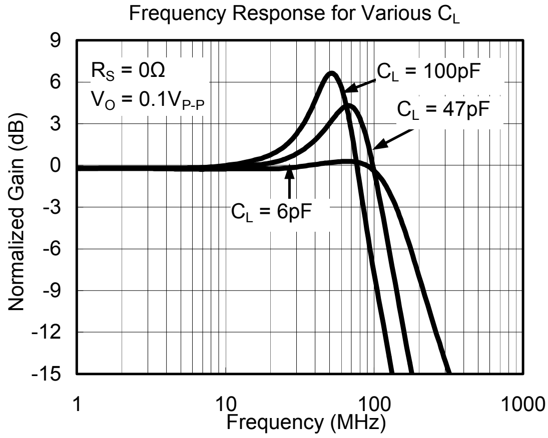
Frequency Response vs. C_L



0.1dB Gain Flatness for Various R_F



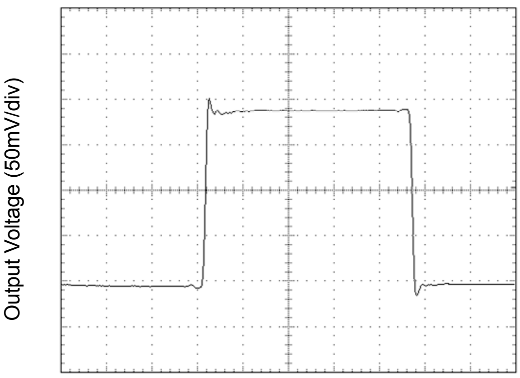
Frequency Response for Various C_L



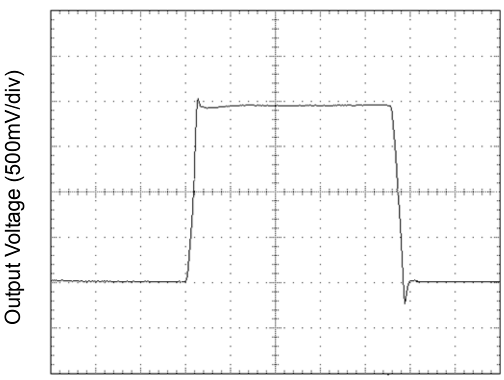
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_S = +5V, G = +2, R_F = 600Ω, R_G = 600Ω, and R_L= 150Ω connected to Vs/2, unless otherwise noted.

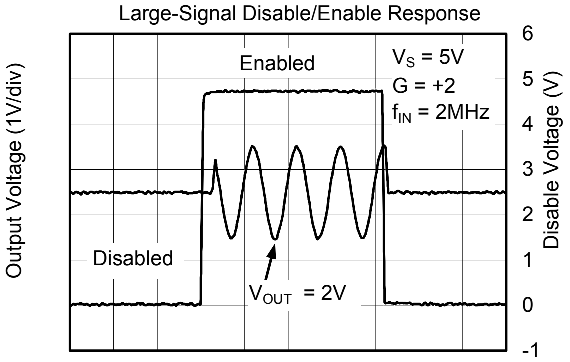
Non-Inverting Small Signal Step Response



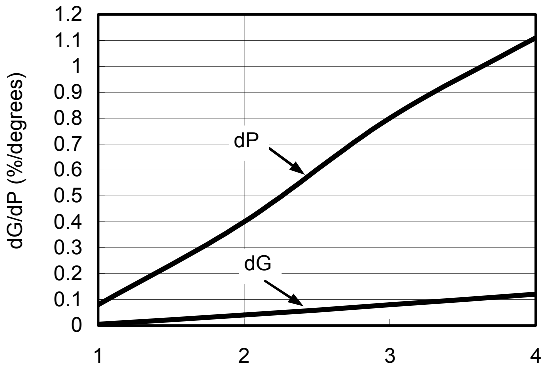
Non-Inverting Large Signal Step Response



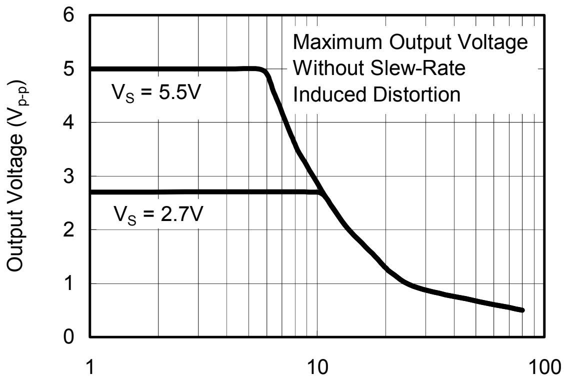
Large-Signal Disable/Enable Response



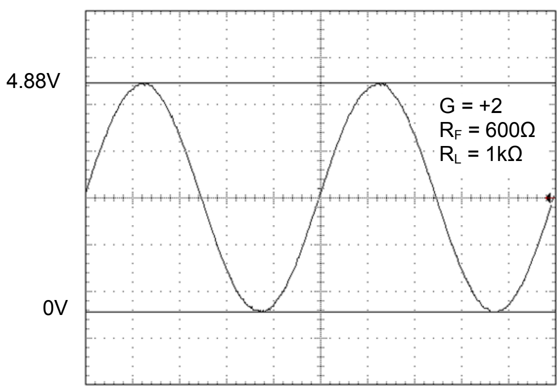
Composite Video Differential Gain and Phase



Maximum Output Voltage vs. Frequency



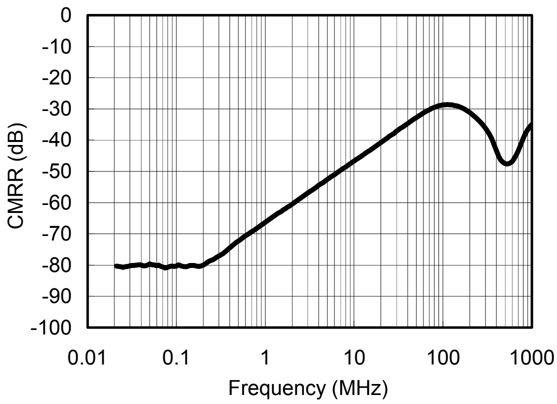
Rail-To-Rail



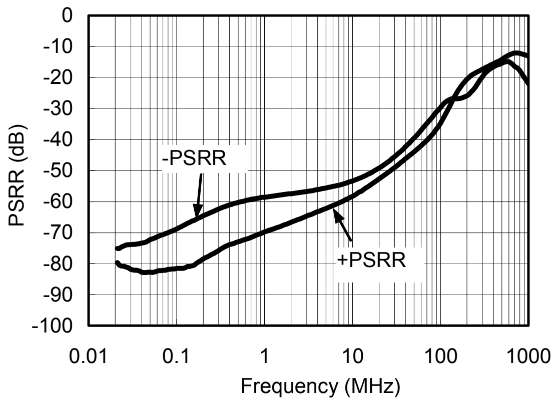
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25°C, V_S = +5V, G = +2, R_F = 600Ω, R_G = 600Ω, and R_L= 150Ω connected to Vs/2, unless otherwise noted.

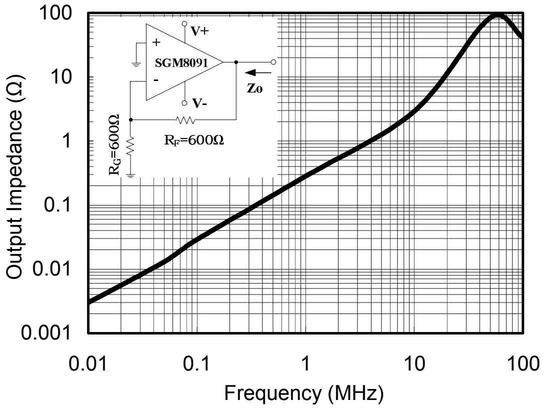
Common-Mode Rejection Ratio vs. Frequency



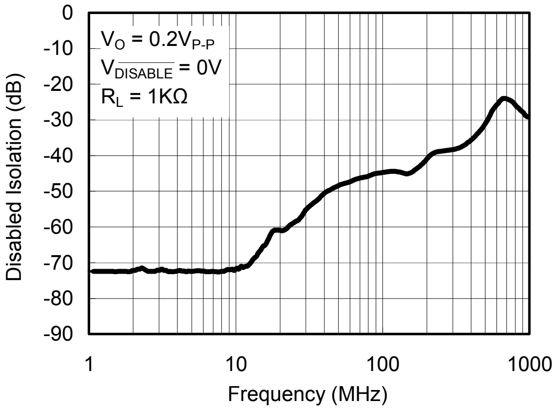
Power-Supply Rejection Ratio vs. Frequency



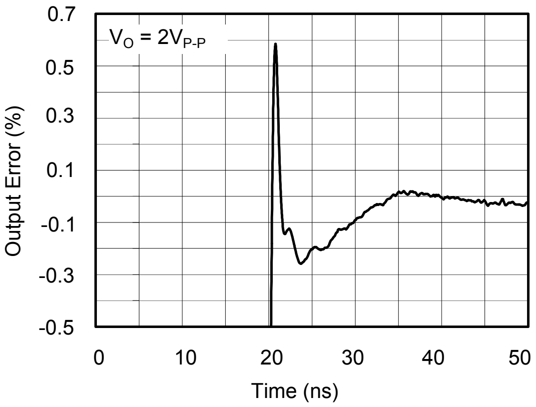
Closed-Loop Output Impedance vs. Frequency



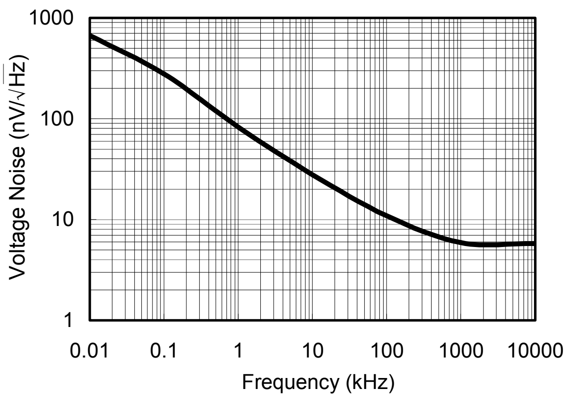
Disabled Output Isolation Frequency Response



Output Settling Time to 0.1%



Input Voltage Noise Spectral Density vs. Frequency



TYPICAL PERFORMANCE CHARACTERISTICS

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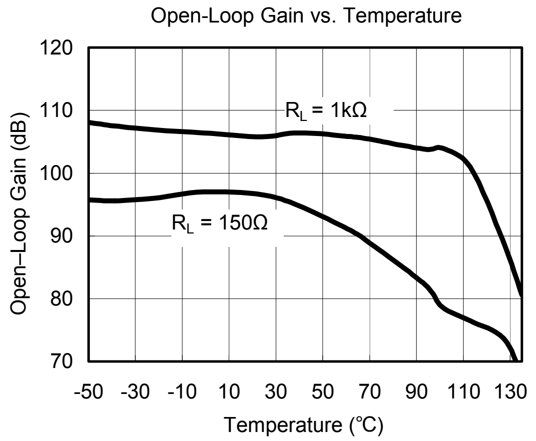
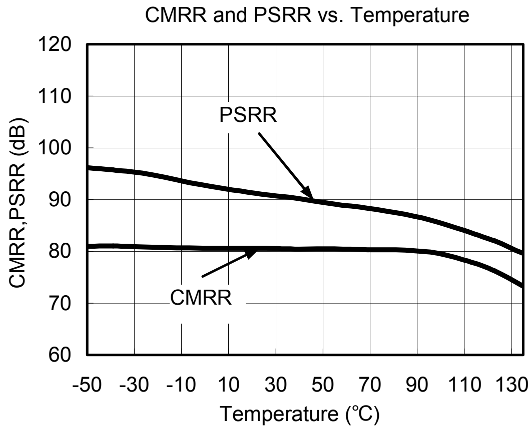
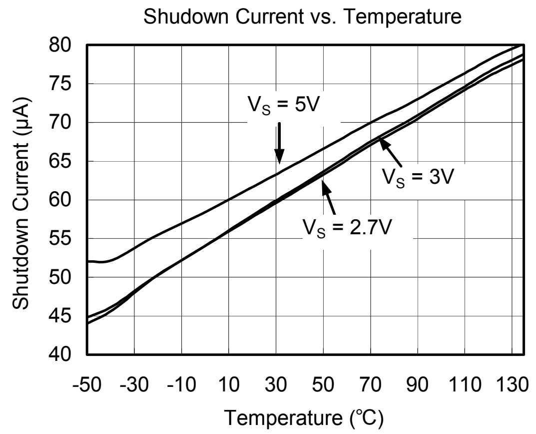
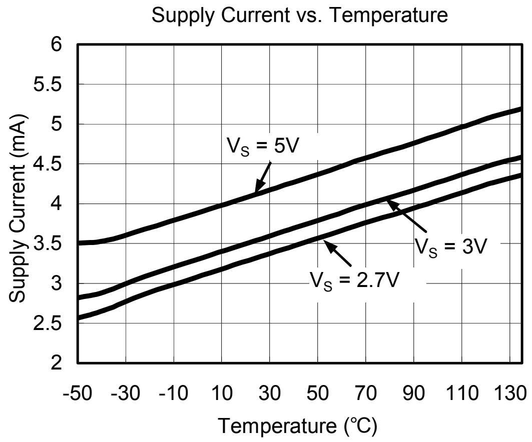
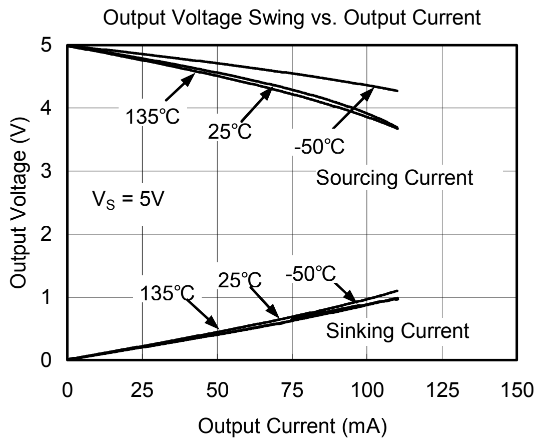
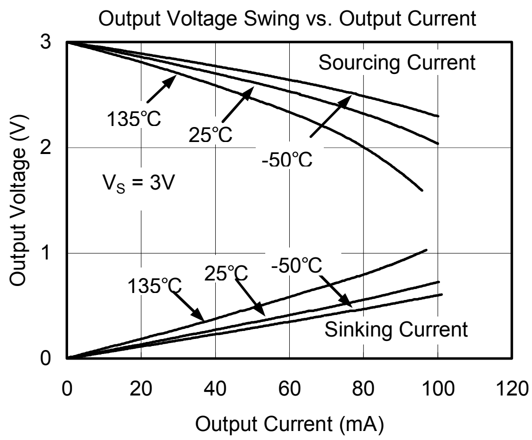






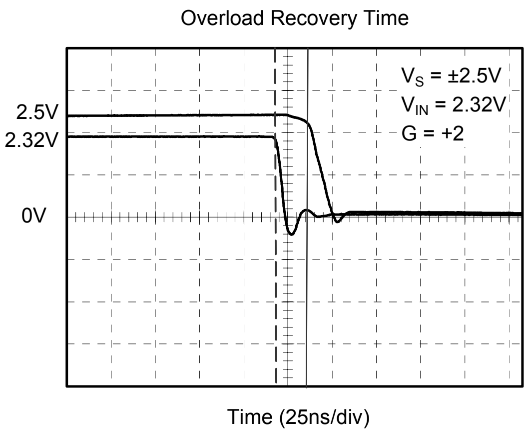


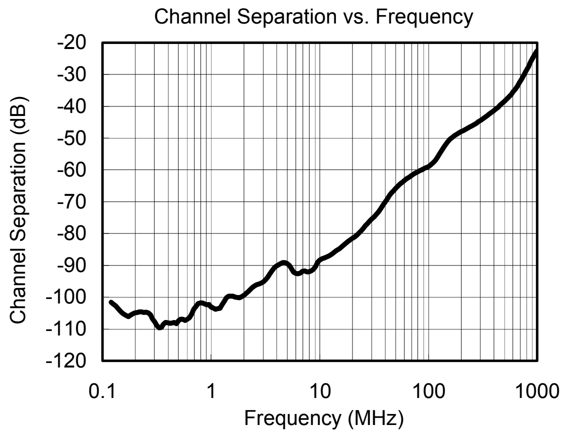


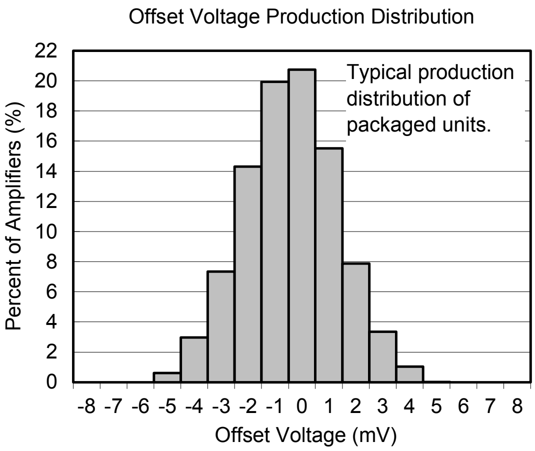


TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25°C, V_S = +5V, G = +2, R_F = 600Ω, R_G = 600Ω, and R_L= 150Ω connected to Vs/2, unless otherwise noted.







APPLICATION NOTES

Driving Capacitive Loads

The SGM809x 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 1 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.

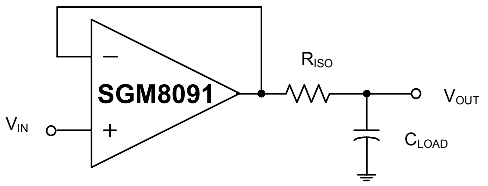


Figure 1. Series Resistor Isolating Capacitive Load

Power-Supply Bypassing and Layout

The SGM809x family operates from either a single +2.7V to +5.5V supply or dual ±1.35V to ±2.75V supplies. For single-supply operation, bypass the power supply V_{DD} with a 0.1μF ceramic capacitor which should be placed close to the V_{DD} pin. For dual-supply operation, both the V_{DD} and the V_{SS} supplies should be bypassed to ground with separate 0.1μF ceramic capacitors. 2.2μF tantalum capacitor can be added for better performance.

Good PC board layout techniques optimize performance by decreasing the amount of stray capacitance at the op amp's inputs and output. To decrease stray capacitance, minimize trace lengths and widths by placing external components as close to the device as possible. Use surface-mount components whenever possible.

For the high speed operational amplifier, soldering the part to the board directly is strongly recommended. Try to keep the high frequency big current loop area small to minimize the EMI (electromagnetic interfacing).

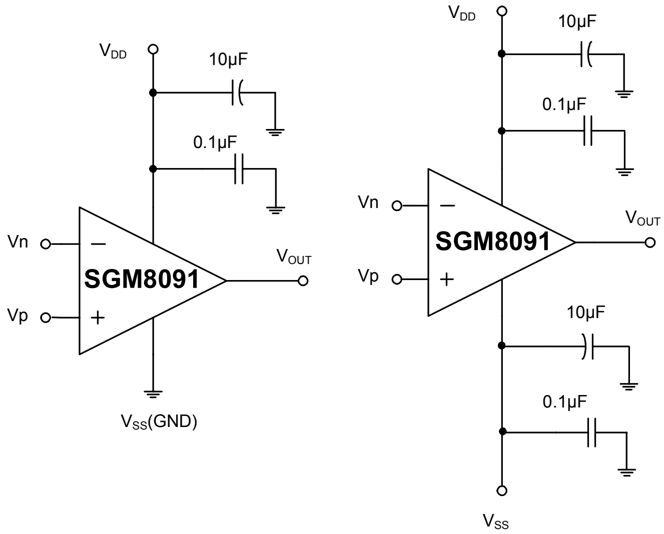


Figure 2. Amplifier with Bypass Capacitors

Grounding

A ground plane layer is important for high speed circuit design. The length of the current path speed currents in an inductive ground return will create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance.

Input-to-Output Coupling

To minimize capacitive coupling, the input and output signal traces should not be parallel. This helps reduce unwanted positive feedback.

TYPICAL APPLICATION CIRCUITS

Differential Amplifier

The circuit shown in Figure 3 performs the difference function. If the resistors ratios are equal (R_4 / R_3 = R_2 / R_1), then
V_{OUT} = (Vp – Vn) × R_2 / R_1 + V_{REF}.

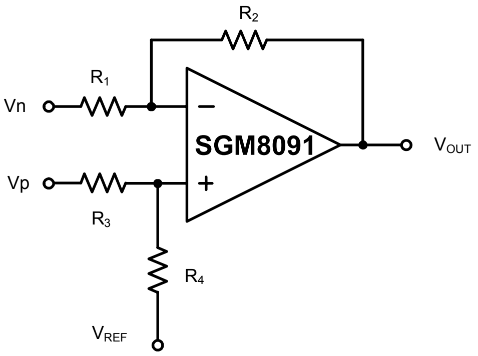


Figure 3. Differential Amplifier

Low Pass Active Filter

The low pass filter shown in Figure 4 has a DC gain of ($-R_2/R_1$) and the –3dB corner frequency is $1/2\pi R_2C$. Make sure the filter is within the bandwidth of the amplifier. The Large values of feedback resistors can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistors value as low as possible and consistent with output loading consideration.

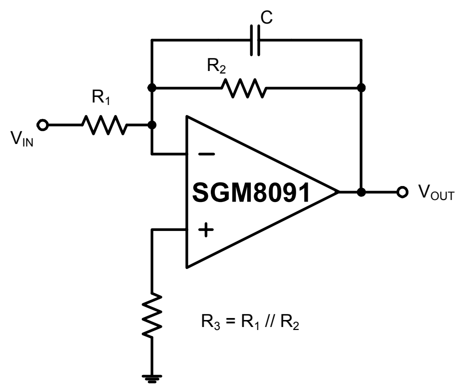


Figure 4. Low Pass Active Filter

Driving Video

The SGM809x can be used in video applications like in Figure 5.

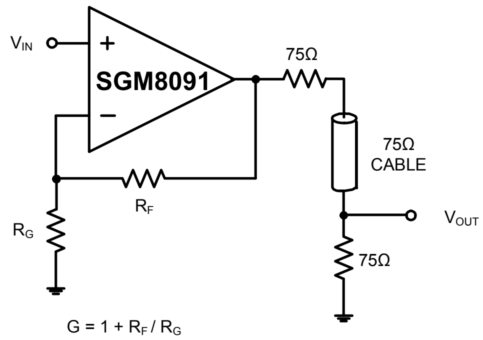
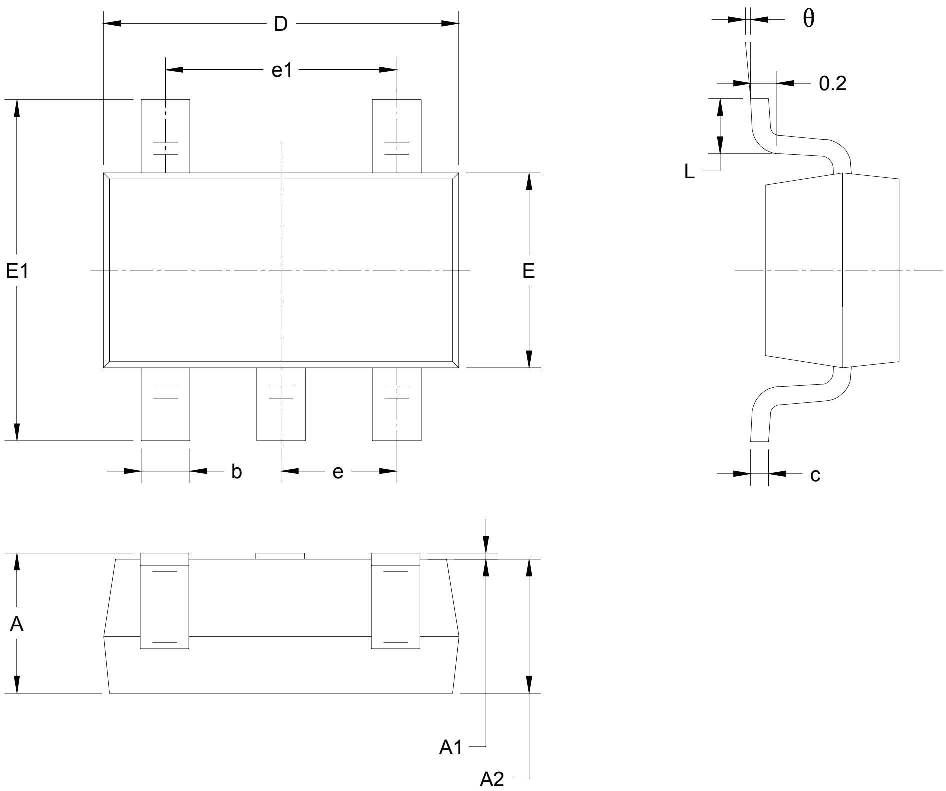


Figure 5. Typical Video Driving

PACKAGE OUTLINE DIMENSIONS

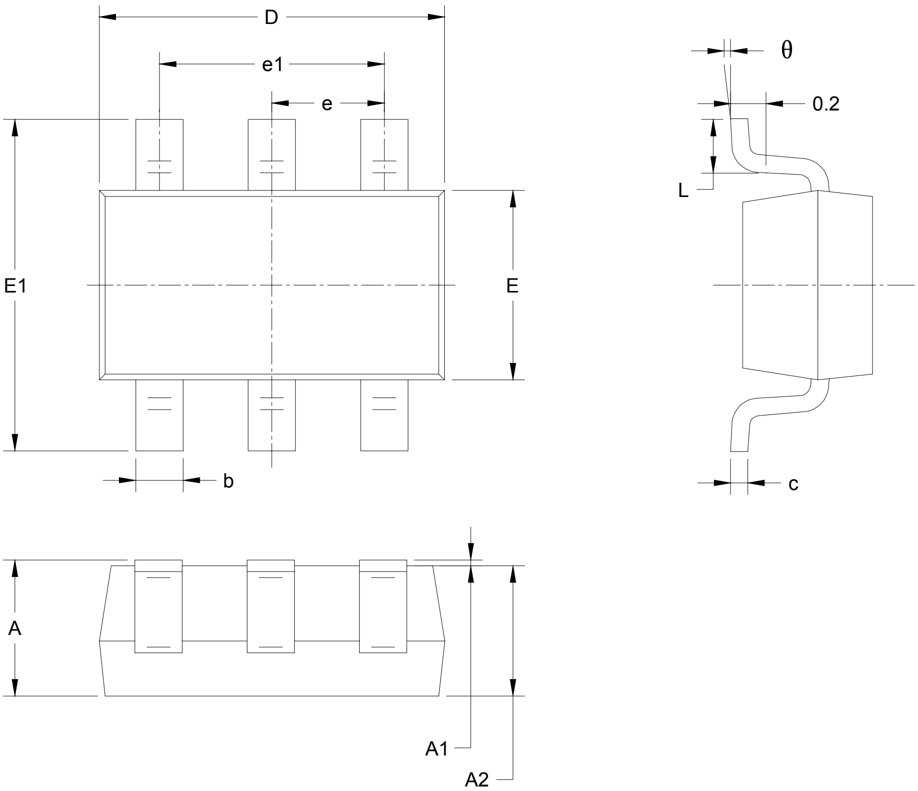
SOT-23-5



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°

PACKAGE OUTLINE DIMENSIONS

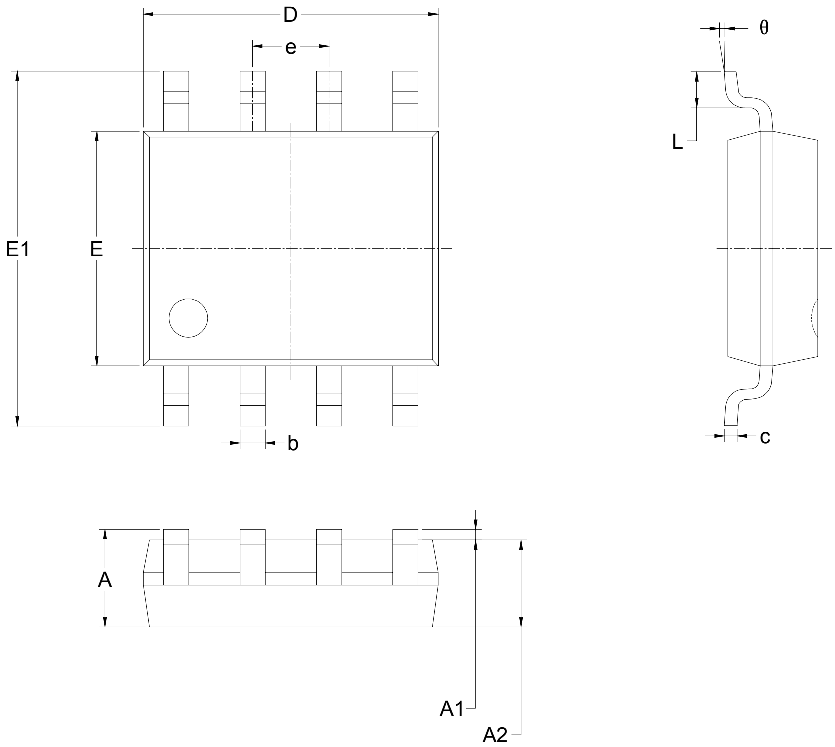
SOT-23-6



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°

PACKAGE OUTLINE DIMENSIONS

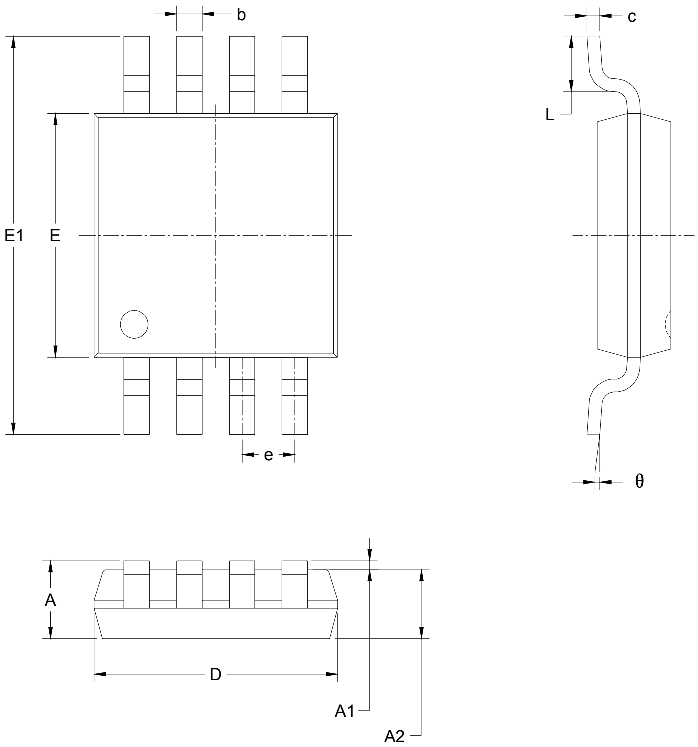
SOIC-8



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°

PACKAGE OUTLINE DIMENSIONS

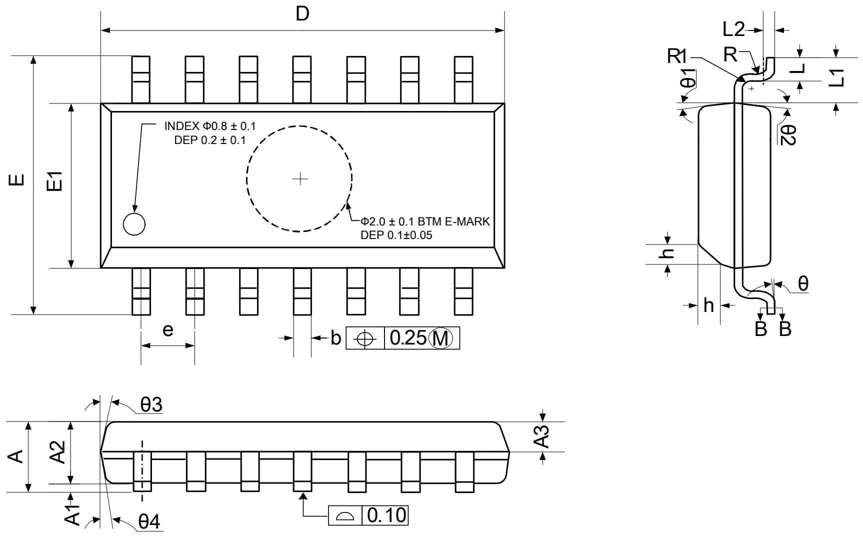
MSOP-8



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°

PACKAGE OUTLINE DIMENSIONS

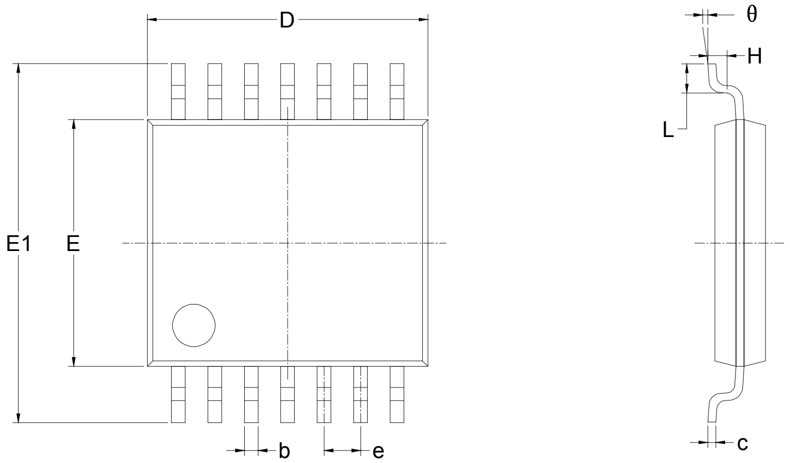
SOIC-14

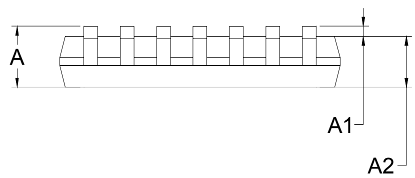


Symbol	Dimensions In Millimeters			Dimensions In Inches		
	MIN	MOD	MAX	MIN	MOD	MAX
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
A2	1.25		1.65	0.049		0.065
A3	0.55		0.75	0.022		0.030
D	8.53		8.73	0.336		0.344
E	5.80		6.20	0.228		0.244
E1	3.80		4.00	0.150		0.157
e	1.27 BSC			0.050 BSC		
L	0.45		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°
θ1	6°	8°	10°	6°	8°	10°
θ2	6°	8°	10°	6°	8°	10°
θ3	5°	7°	9°	5°	7°	9°
θ4	5°	7°	9°	5°	7°	9°

PACKAGE OUTLINE DIMENSIONS

TSSOP-14





Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.100		0.043
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1°	7°	1°	7°