

SGM8091/SGM8092 SGM8093/SGM8094 350MHz, Rail-to-Rail Output CMOS Operational Amplifiers

GENERAL DESCRIPTION

The SGM8091/3 (single), SGM8092 (dual) and 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 supply 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 0.1dB flatness out to 125MHz ($G = +1$) and offer a typical low power of 4.3mA/amplifier.

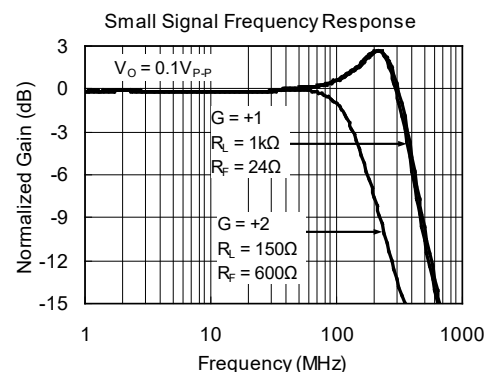
The SGM8091 series are low distortion and fast settling, making them ideal for buffering high speed A/D or D/A converters. The SGM8093 has a power-down disable feature that reduces the supply current to 75 μ A. These features make the SGM8093 ideal for portable and battery-powered applications where size and power are critical. All are specified over the extended -40°C to $+125^{\circ}\text{C}$ temperature range.

APPLICATIONS

Imaging
Photodiode Preamp
Professional Video and Camera
Hand Set
DVD/CD
Base Station
Filter
A-to-D Driver

FEATURES

- **Rail-to-Rail Output**
- **Input Offset Voltage: 8mV (MAX)**
- **High Speed:**
 - 350MHz, -3dB Bandwidth ($G = +1$)**
 - 265V/ μ s, Slew Rate**
 - 32ns Settling Time to 0.1% with 2V Step**
- **Supply Voltage Range: 2.5V to 5.5V**
- **Input Voltage Range: -0.2V to 3.8V with $V_S = 5\text{V}$**
- **Excellent Video Specs ($R_L = 150\Omega$, $G = +2$):**
 - Gain Flatness 0.1dB to 70MHz**
 - Diff Gain: 0.004%, Diff Phase: 0.08 Degree**
- **Low Supply Current:**
 - 4.3mA/Amplifier (TYP)**
 - 75 μ A Shutdown Current for SGM8093**
- **-40°C to $+125^{\circ}\text{C}$ Operating Temperature Range**
- **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**



SGM8091/SGM8092 SGM8093/SGM8094

350MHz, Rail-to-Rail Output CMOS Operational Amplifiers

PACKAGE/ORDERING INFORMATION

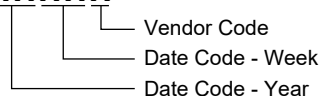
MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8091	SOT-23-5	-40°C to +125°C	SGM8091XN5/TR	8091	Tape and Reel, 3000
	SOIC-8	-40°C to +125°C	SGM8091XS/TR	SGM8091XS XXXXX	Tape and Reel, 2500
SGM8092	SOIC-8	-40°C to +125°C	SGM8092XS/TR	SGM8092XS XXXXX	Tape and Reel, 2500
	MSOP-8	-40°C to +125°C	SGM8092XMS/TR	SGM8092 XMS XXXXX	Tape and Reel, 3000
SGM8093	SOT-23-6	-40°C to +125°C	SGM8093XN6/TR	8093	Tape and Reel, 3000
	SOIC-8	-40°C to +125°C	SGM8093XS/TR	SGM8093XS XXXXX	Tape and Reel, 2500
SGM8094	SOIC-14	-40°C to +125°C	SGM8094XS14/TR	SGM8094XS14 XXXXX	Tape and Reel, 2500
	TSSOP-14	-40°C to +125°C	SGM8094XTS14/TR	SGM8094 XTS14 XXXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXXX = Date Code and Vendor Code.

SOIC-8/MSOP-8/SOIC-14/TSSOP-14

XXXXX



Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

SGM8091/SGM8092 SGM8093/SGM8094

350MHz, Rail-to-Rail Output CMOS Operational Amplifiers

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $+V_S$ to $-V_S$	7.5V
Input Common Mode Voltage Range	$(-V_S) - 0.5V$ to $(+V_S) + 0.5V$
Package Thermal Resistance @ $T_A = +25^{\circ}C$	
SOT-23-5, θ_{JA}	190°C/W
SOT-23-6, θ_{JA}	190°C/W
SOIC-8, θ_{JA}	125°C/W
MSOP-8, θ_{JA}	216°C/W
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 10s)	+260°C
ESD Susceptibility	
HBM.....	1000V
MM.....	400V

RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range	-40°C to +125°C
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OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

ESD SENSITIVITY CAUTION

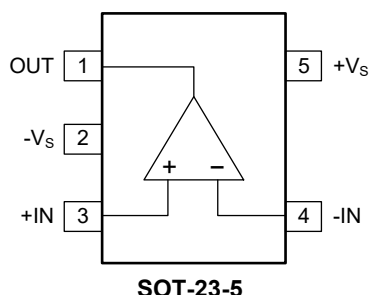
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

DISCLAIMER

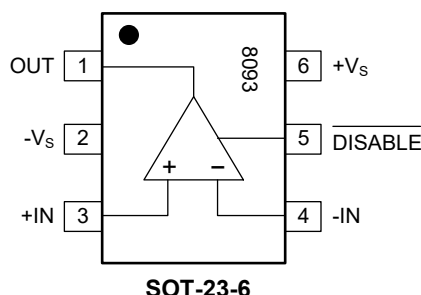
SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATIONS

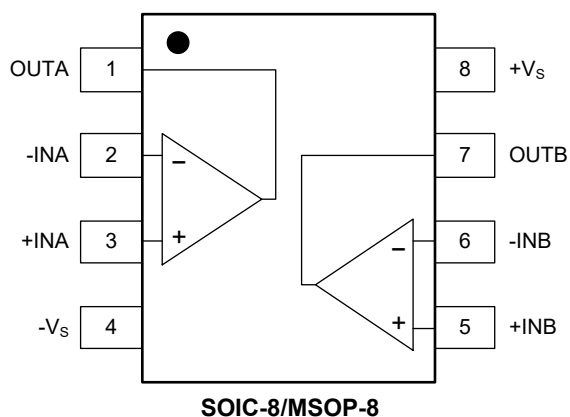
SGM8091 (TOP VIEW)



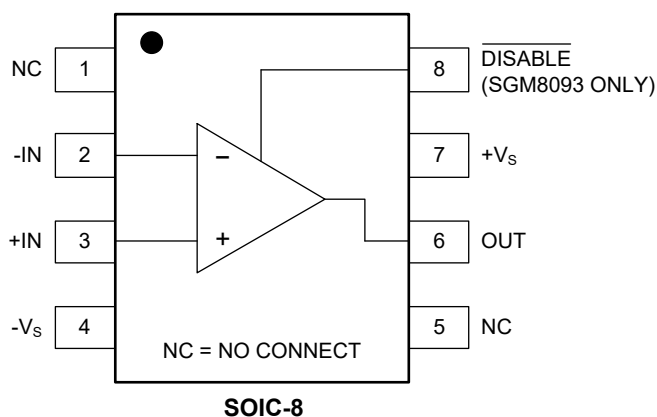
SGM8093 (TOP VIEW)



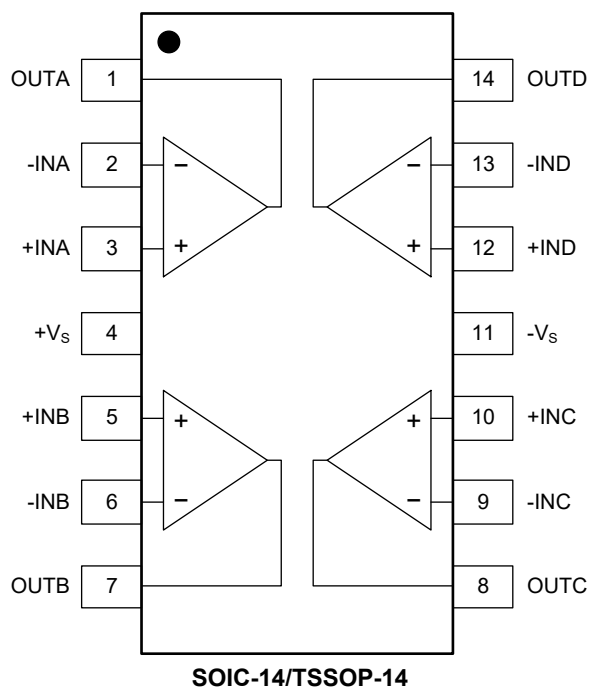
SGM8092 (TOP VIEW)



SGM8091/8093 (TOP VIEW)



SGM8094 (TOP VIEW)



SGM8091/SGM8092

SGM8093/SGM8094

350MHz, Rail-to-Rail Output

CMOS Operational Amplifiers

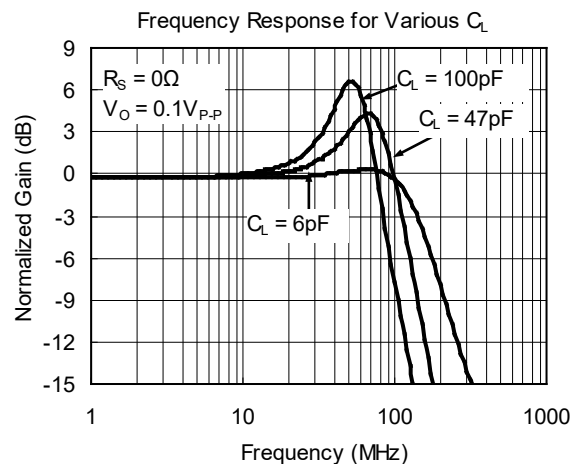
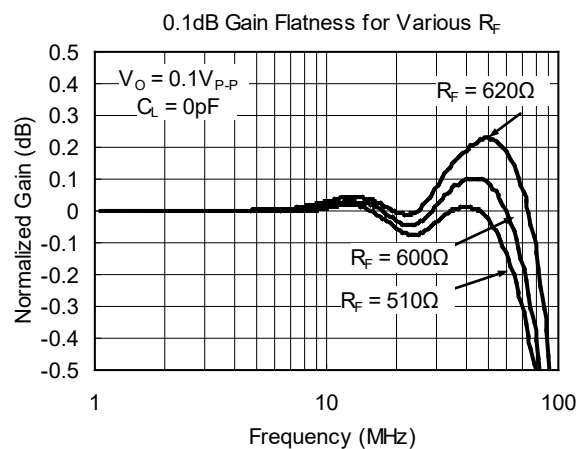
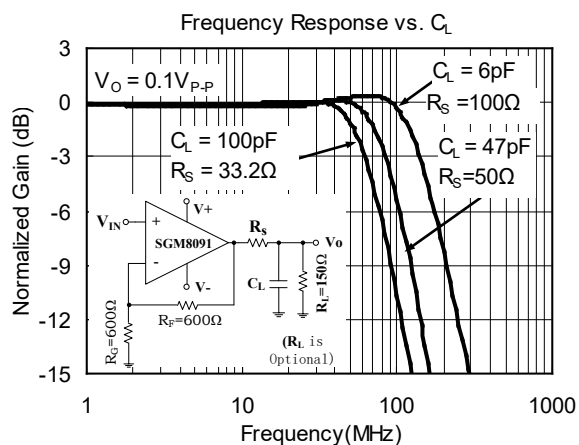
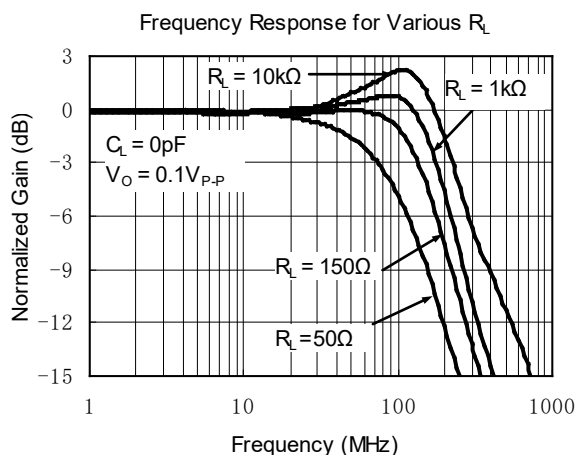
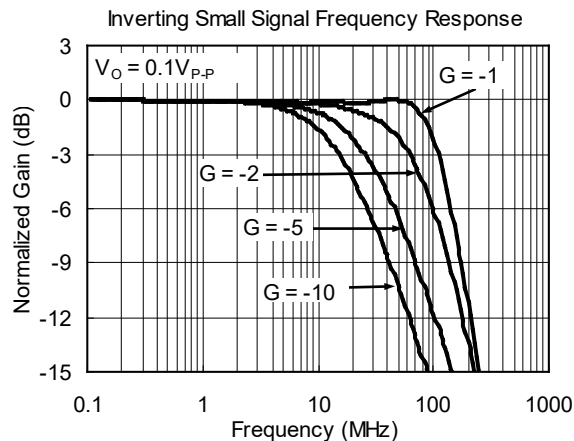
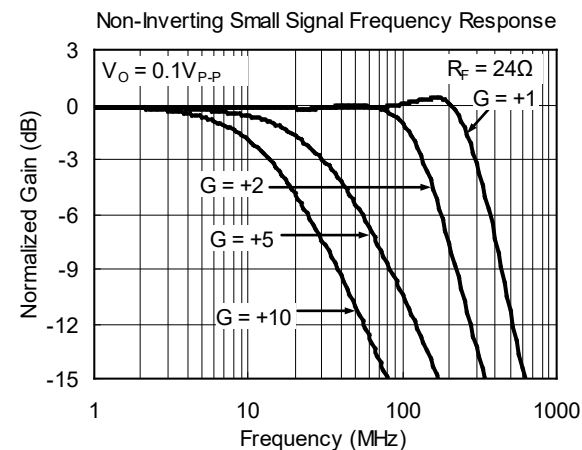
ELECTRICAL CHARACTERISTICS

(V_S = 5V, G = +2, R_F = 600Ω, R_L = 150Ω, unless otherwise noted.)

PARAMETER	CONDITIONS	SGM8091/2/3/4						
		TYP	MIN/MAX OVER TEMPERATURE					MIN/ MAX
		+25°C	+25°C	0°C to +70°C	-40°C to +70°C	-40°C to +125°C	UNITS	
Dynamic Performance								
-3dB Small Signal Bandwidth	G = +1, V _O = 0.1V _{P-P} , R _F = 24Ω, R _L = 150Ω	300					MHz	TYP
	G = +1, V _O = 0.1V _{P-P} , R _F = 24Ω, R _L = 1kΩ	350					MHz	TYP
	G = +2, V _O = 0.1V _{P-P} , R _L = 50Ω	70					MHz	TYP
	G = +2, V _O = 0.1V _{P-P} , R _L = 150Ω	140					MHz	TYP
	G = +2, V _O = 0.1V _{P-P} , R _L = 1kΩ	170					MHz	TYP
	G = +2, V _O = 0.1V _{P-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, V _O = 0.1V _{P-P}	125					MHz	TYP
	G = +2, V _O = 0.1V _{P-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, V _O = 0.2V _{P-P} , 10% to 90%	3.8					ns	TYP
	G = +2, V _O = 2V _{P-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/√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/°C	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
$\overline{\text{DISABLE}}$ Voltage-Off			0.8				V	MAX
$\overline{\text{DISABLE}}$ 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

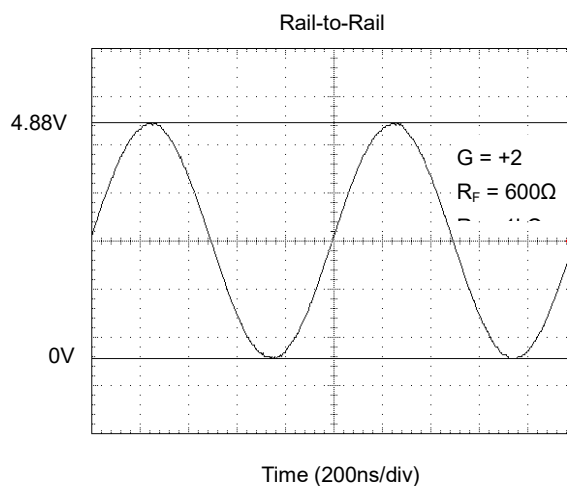
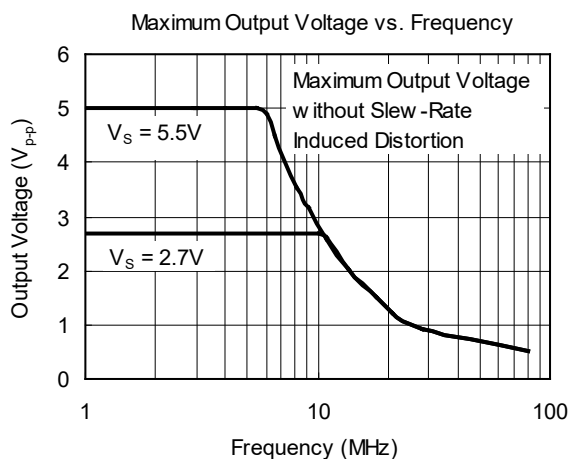
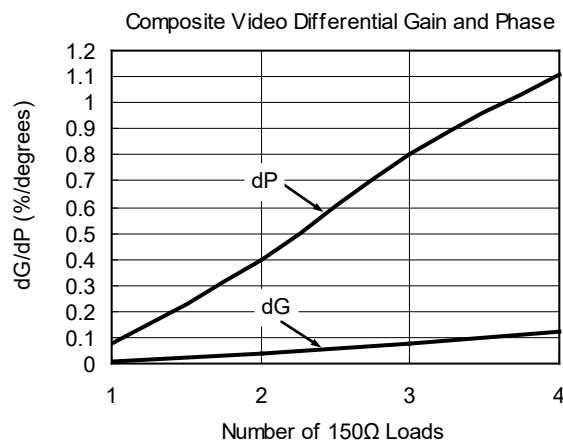
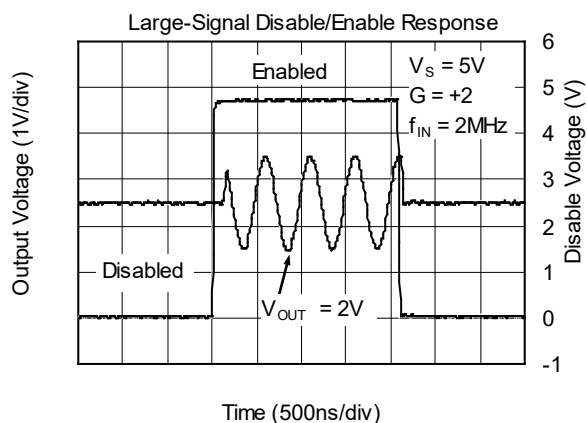
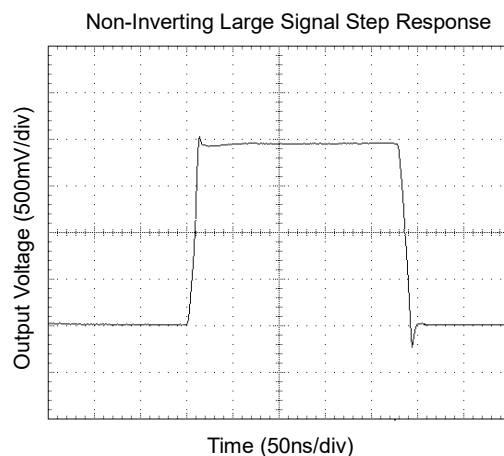
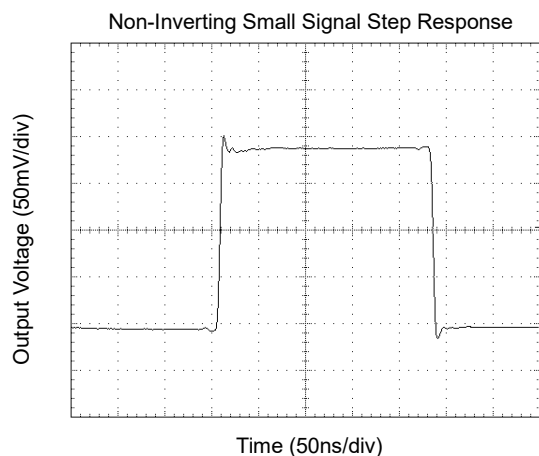
TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = 5\text{V}$, $G = +2$, $R_F = 600\Omega$, $R_G = 600\Omega$, and $R_L = 150\Omega$ connected to $V_S/2$, unless otherwise noted.



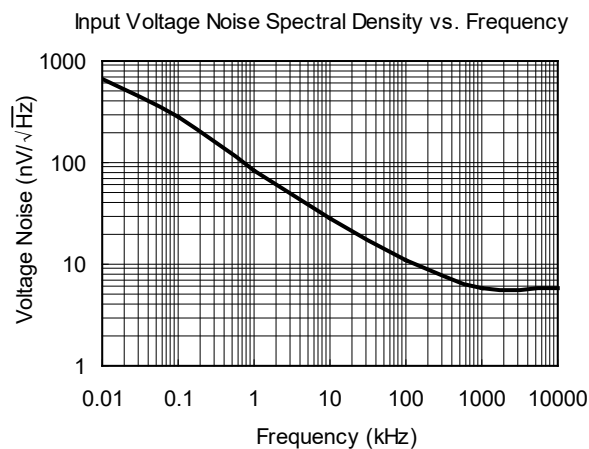
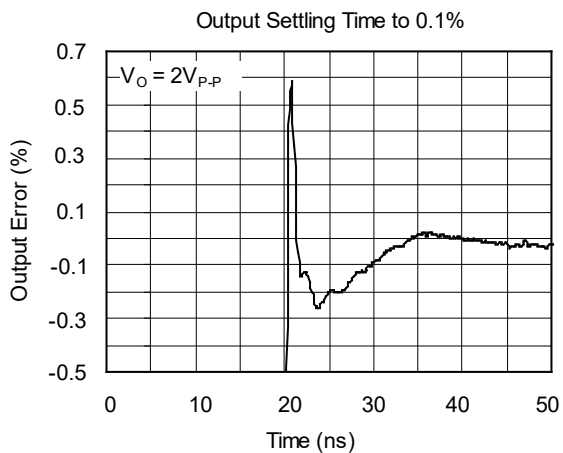
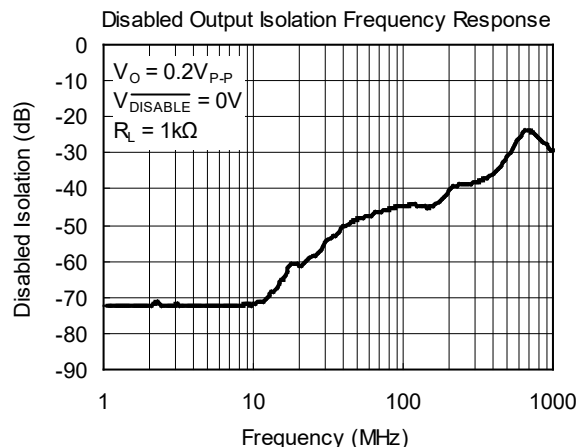
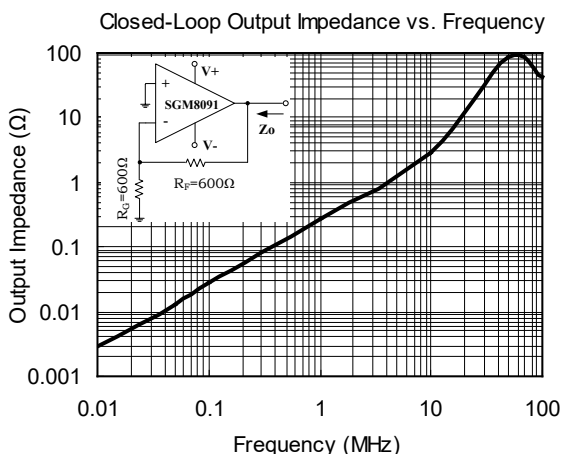
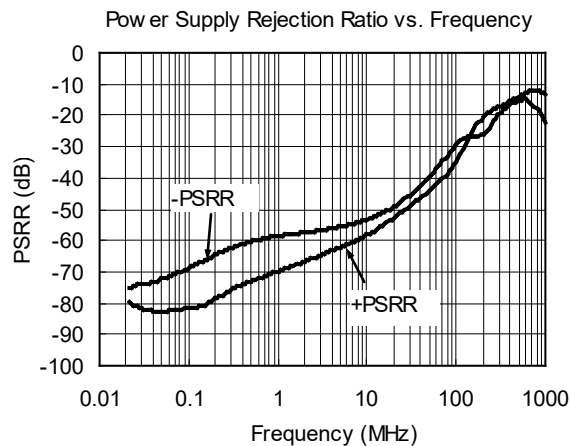
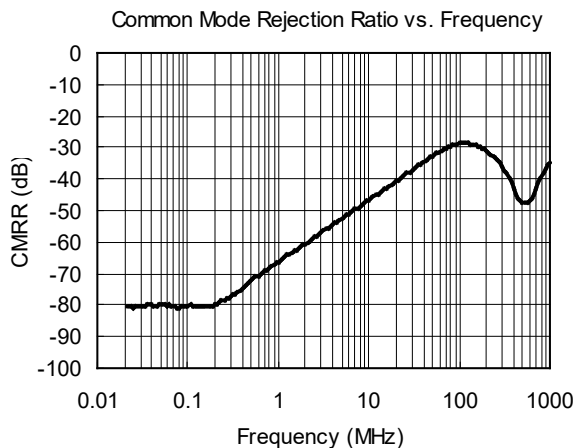
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = 5\text{V}$, $G = +2$, $R_F = 600\Omega$, $R_G = 600\Omega$, and $R_L = 150\Omega$ connected to $V_S/2$, unless otherwise noted.



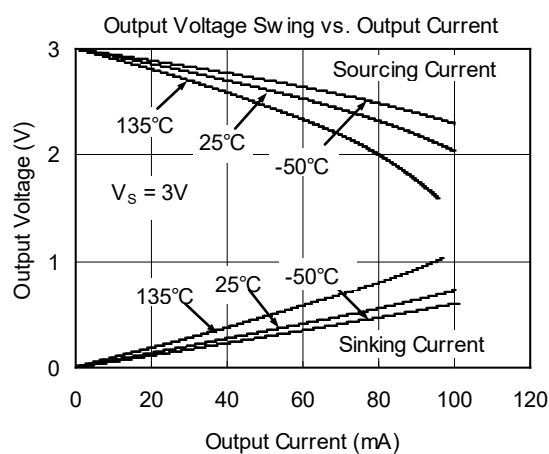
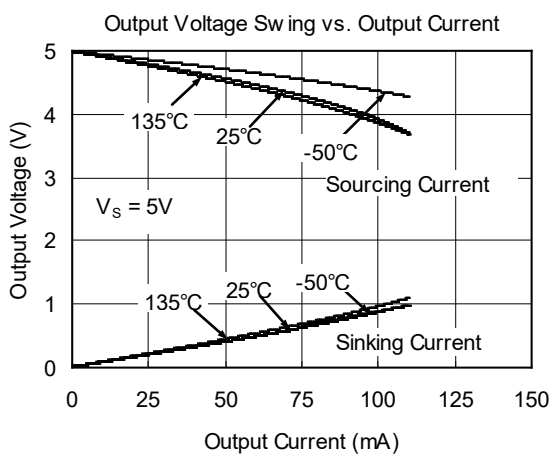
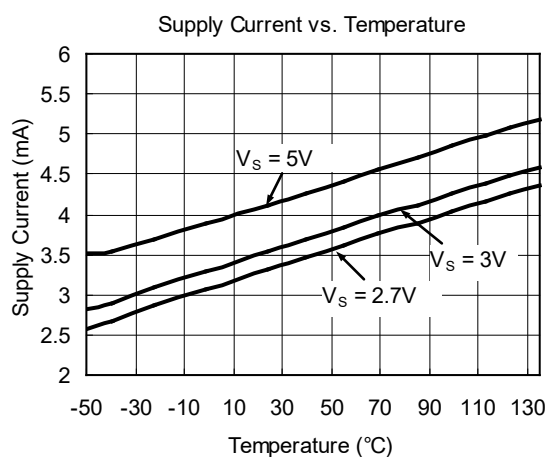
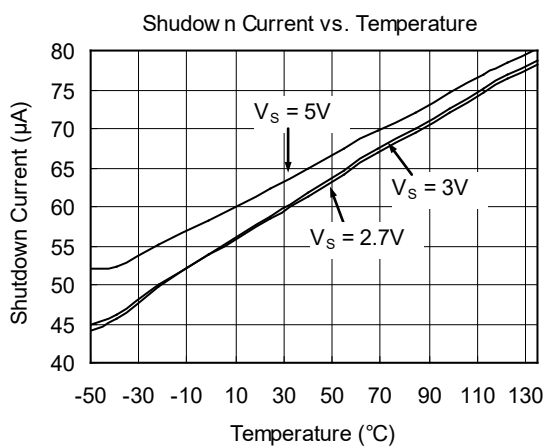
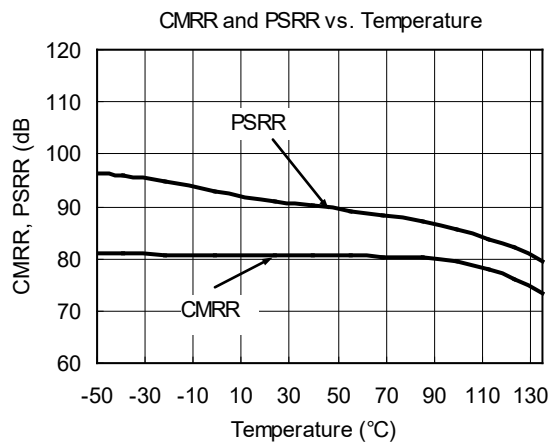
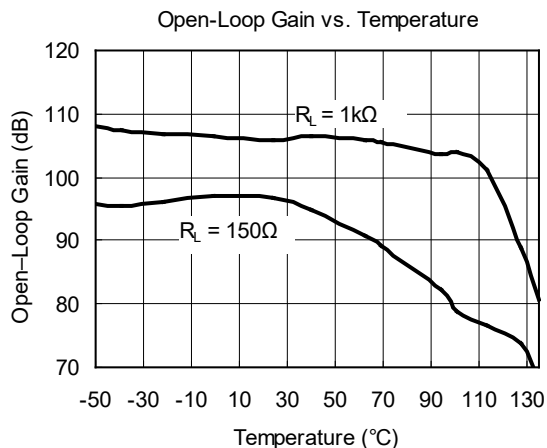
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = 5\text{V}$, $G = +2$, $R_F = 600\Omega$, $R_G = 600\Omega$, and $R_L = 150\Omega$ connected to $V_S/2$, unless otherwise noted.



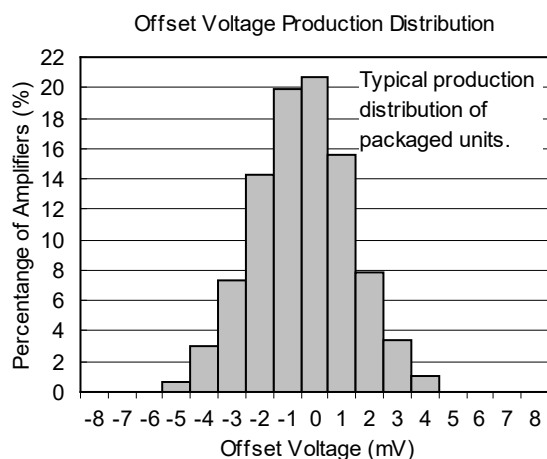
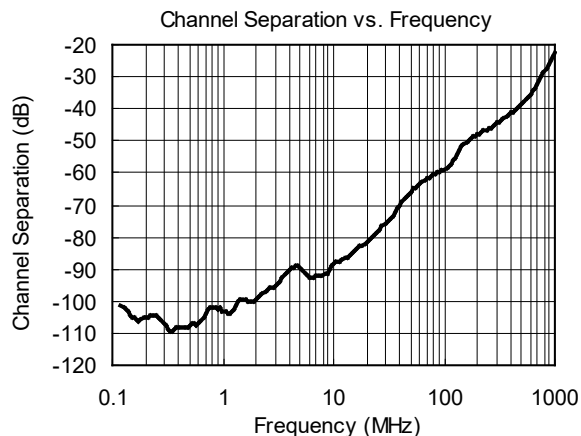
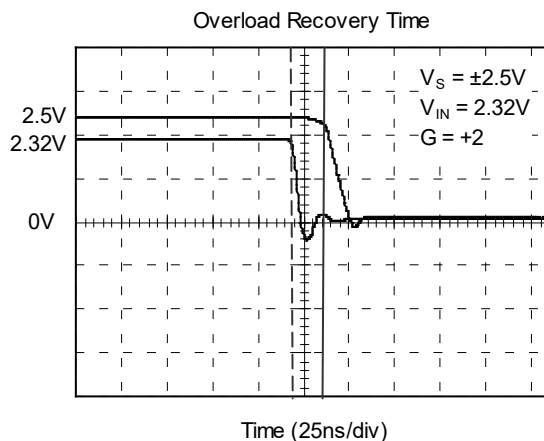
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = 5\text{V}$, $G = +2$, $R_F = 600\Omega$, $R_G = 600\Omega$, and $R_L = 150\Omega$ connected to $V_S/2$, unless otherwise noted.



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = 5\text{V}$, $G = +2$, $R_F = 600\Omega$, $R_G = 600\Omega$, and $R_L = 150\Omega$ connected to $V_S/2$, unless otherwise noted.



APPLICATION NOTES

Driving Capacitive Loads

The SGM8091/2/3/4 are 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.

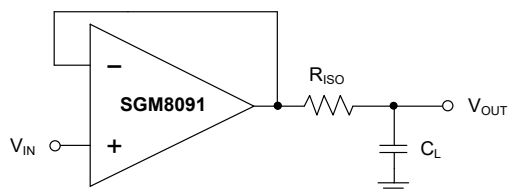


Figure 1. Series Resistor Isolating Capacitive Load

Power Supply Bypassing and Layout

The SGM8091/2/3/4 operate from either a single 2.7V to 5.5V supply or dual $\pm 1.35\text{V}$ to $\pm 2.75\text{V}$ supplies. For single-supply operation, bypass the power supply $+V_S$ with a $0.1\mu\text{F}$ ceramic capacitor which should be placed close to the $+V_S$ pin. For dual-supply operation, both the $+V_S$ and the $-V_S$ supplies should be bypassed to ground with separate $0.1\mu\text{F}$ ceramic capacitors. $2.2\mu\text{F}$ tantalum capacitor can be added for better performance.

Good PC board layout techniques optimize performance by decreasing the amount of stray capacitance at the operational amplifier'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 current loop area small to minimize the EMI (electromagnetic interference).

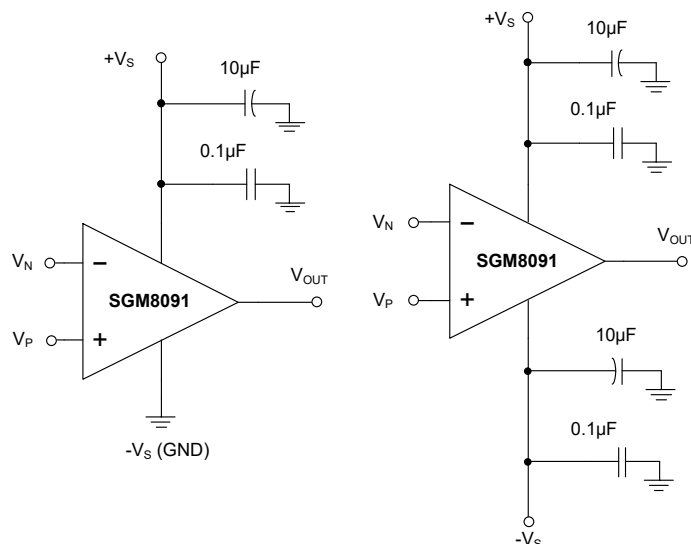


Figure 2. Amplifier with Bypass Capacitors

Grounding

A ground plane layer is important for high speed circuit design. The length of the current path 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 in parallel. This helps reduce unwanted positive feedback.

TYPICAL APPLICATION CIRCUITS

Differential Amplifier

The circuit shown in Figure 3 performs the difference function. If the resistor ratios are equal ($R_4/R_3 = R_2/R_1$), then $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$.

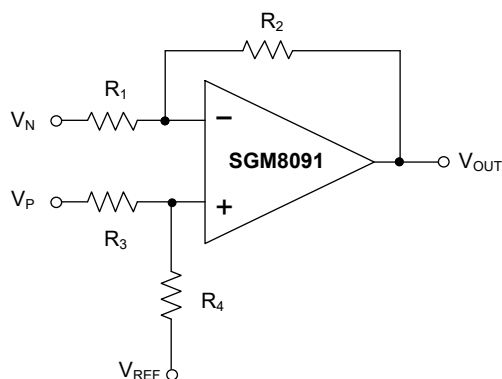


Figure 3. Differential Amplifier

Active Low-Pass Filter

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

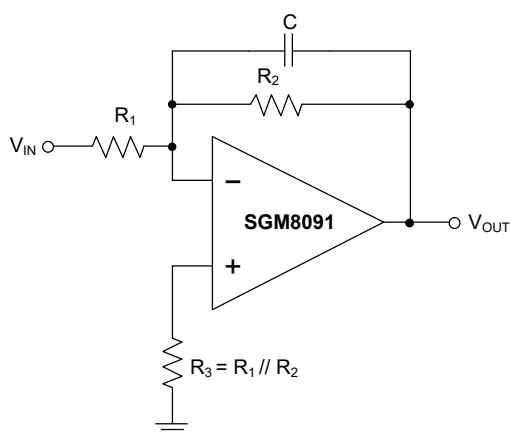


Figure 4. Active Low-Pass Filter

Driving Video

The SGM8091/2/3/4 can be used in video applications as shown in Figure 5.

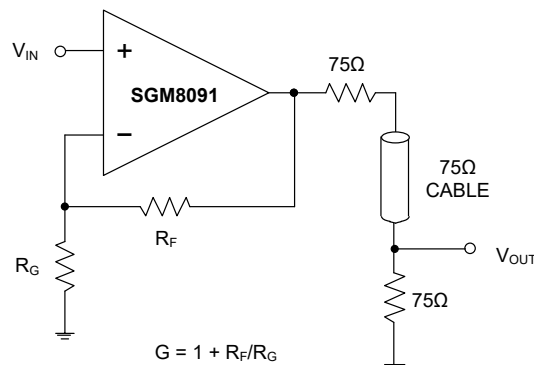


Figure 5. Typical Video Driving

REVISION HISTORY

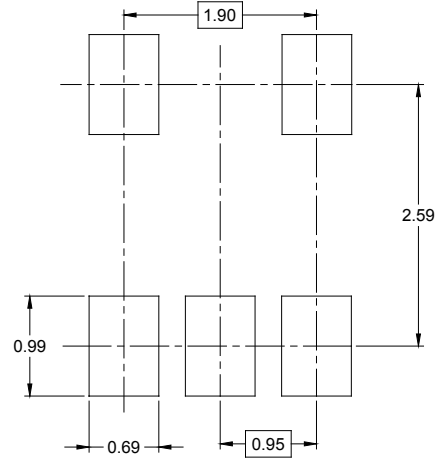
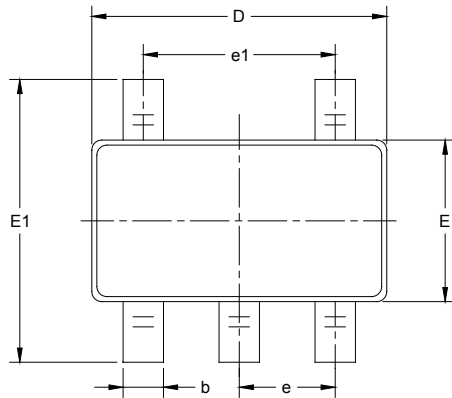
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

JANUARY 2013 – REV.B.3 to REV.B.4	Page
Updated Package Outline Dimensions section	14~19
Added Tape and Reel Information section	20, 21
MAY 2011 – REV.B.2 to REV.B.3	Page
Changed packages' name	All
JUNE 2010 – REV.B.1 to REV.B.2	Page
Changed Electrical Characteristics section	3
Changed Package Outline Dimensions section	11~16
APRIL 2009 – REV.B to REV.B.1	Page
Changed 16pin packages to 14pin packages.....	All
AUGUST 2008 – REV.A to REV.B	Page
Changed Absolute Maximum Ratings section	3
Changes from Original (NOVEMBER 2006) to REV.A	Page
Changed from product preview to production data.....	All

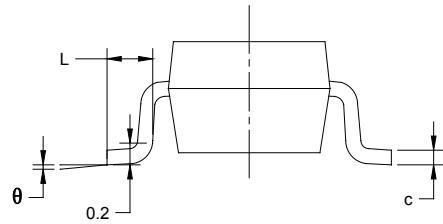
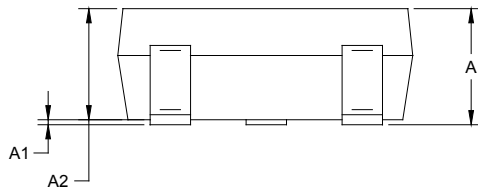
PACKAGE INFORMATION

PACKAGE OUTLINE DIMENSIONS

SOT-23-5



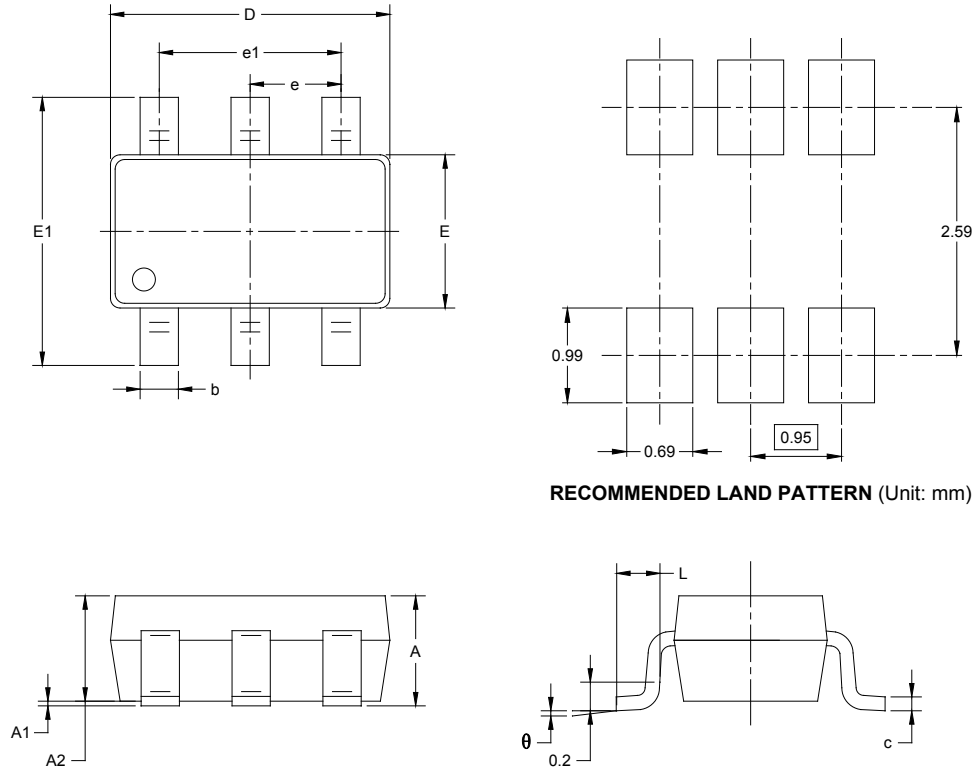
RECOMMENDED LAND PATTERN (Unit: mm)



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

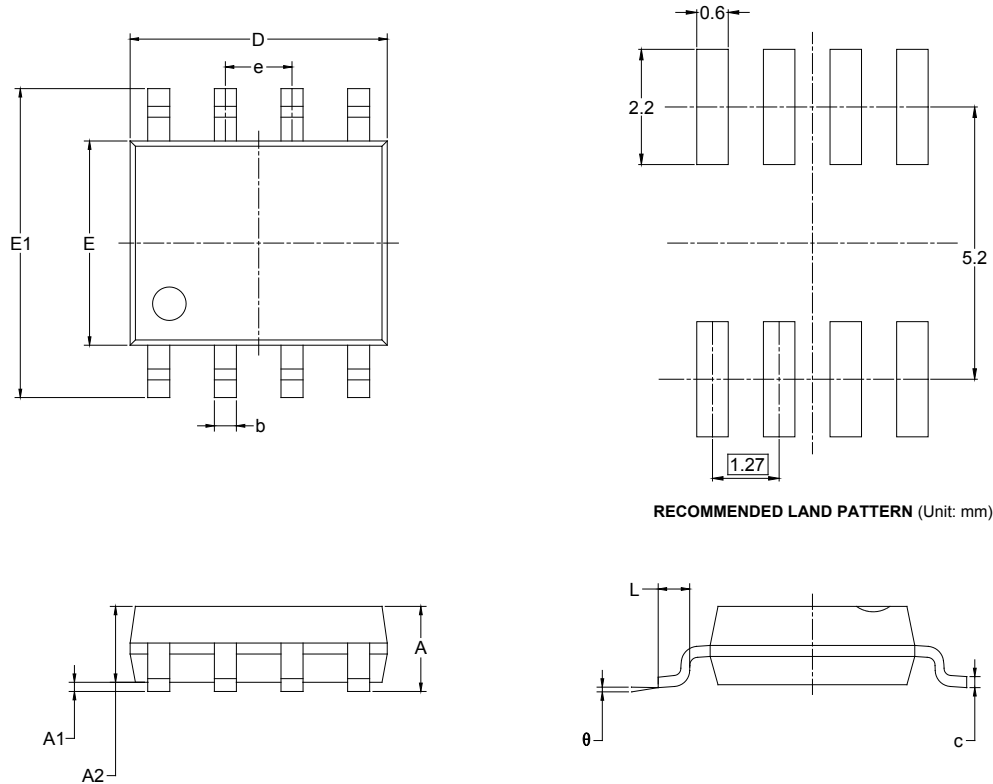


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

PACKAGE INFORMATION

PACKAGE OUTLINE DIMENSIONS

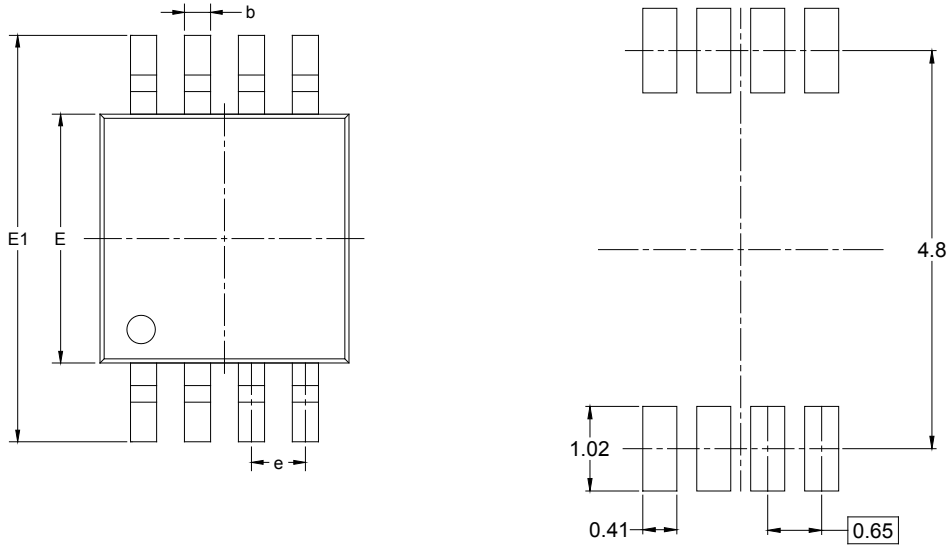
SOIC-8



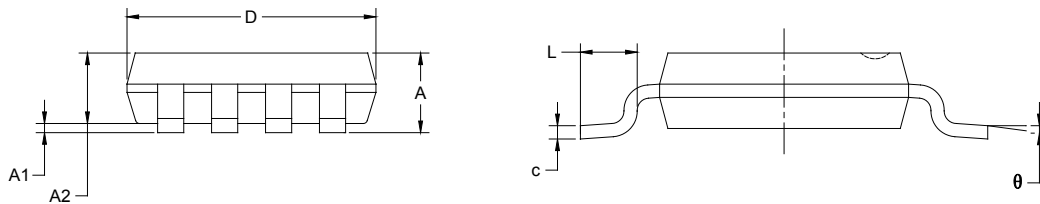
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

PACKAGE OUTLINE DIMENSIONS

MSOP-8



RECOMMENDED LAND PATTERN (Unit: mm)

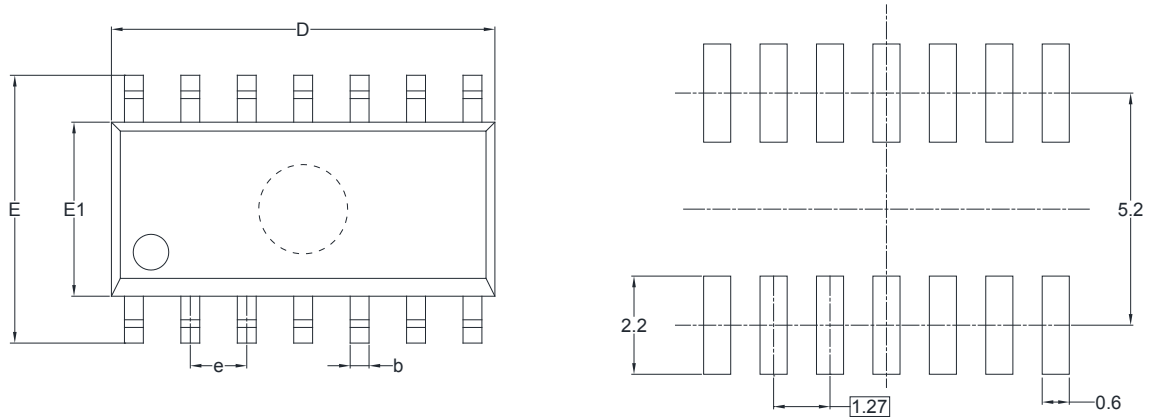


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

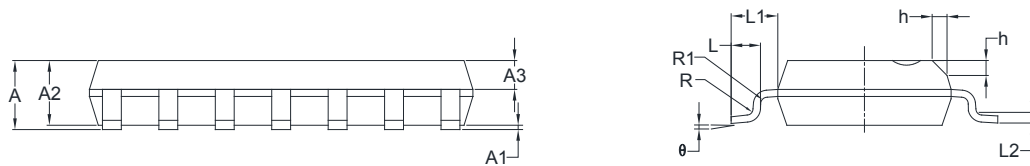
PACKAGE INFORMATION

PACKAGE OUTLINE DIMENSIONS

SOIC-14



RECOMMENDED LAND PATTERN (Unit: mm)

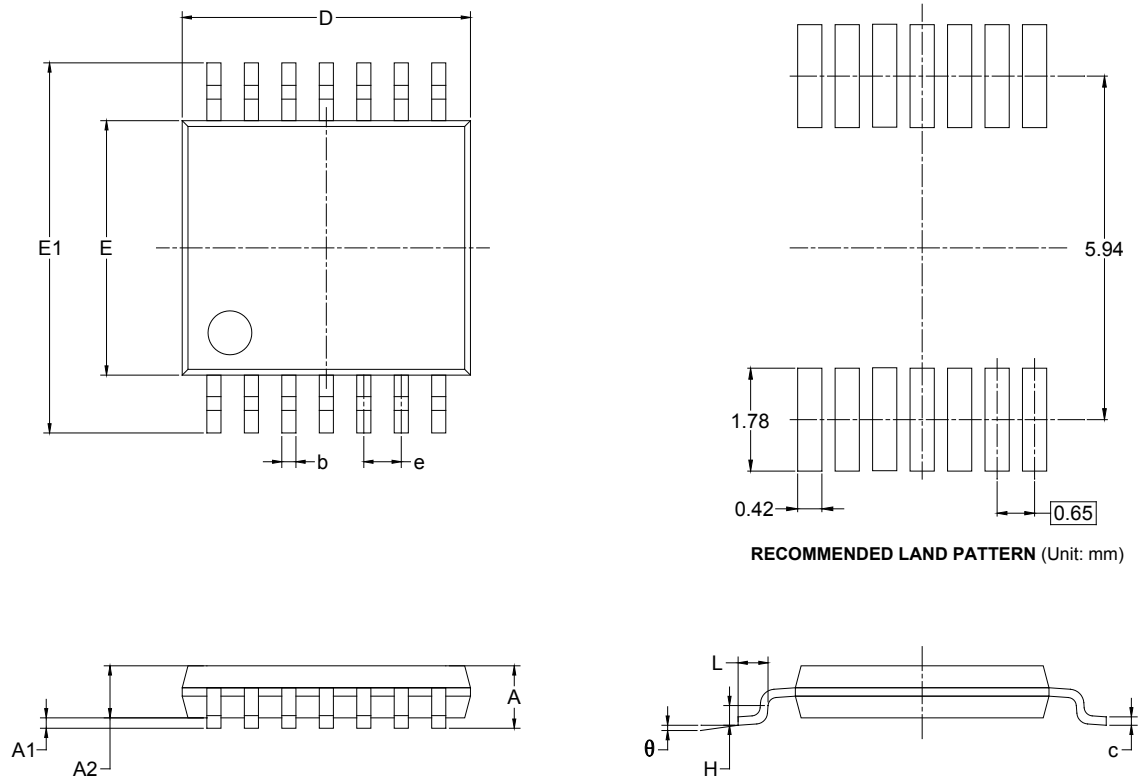


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80	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°

PACKAGE INFORMATION

PACKAGE OUTLINE DIMENSIONS

TSSOP-14

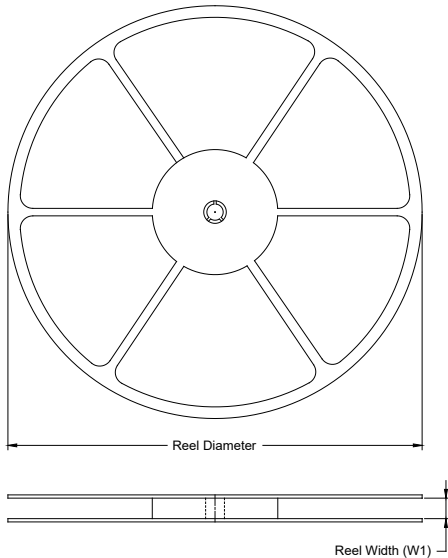


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1°	7°	1°	7°

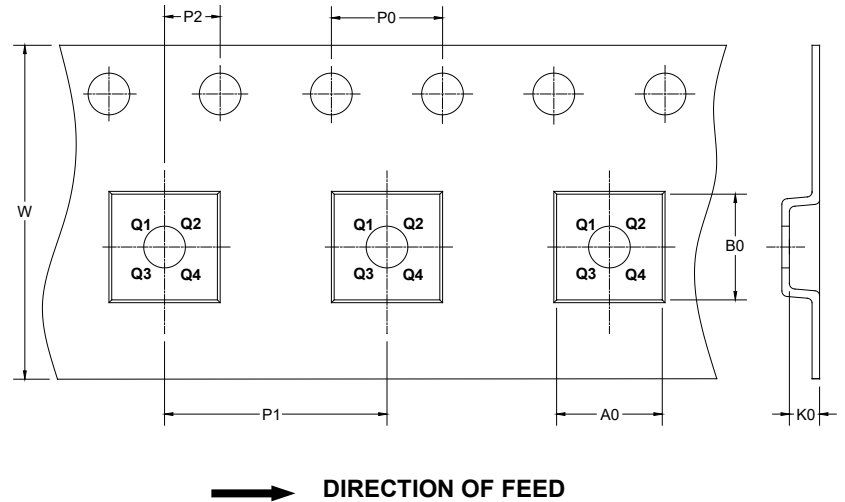
PACKAGE INFORMATION

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



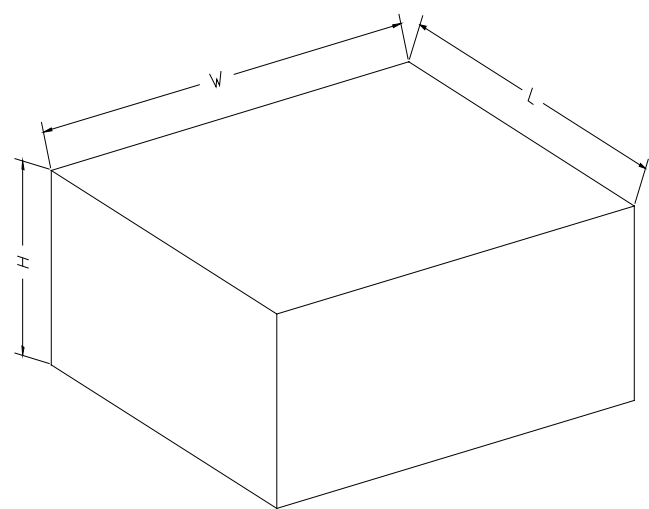
NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT-23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOT-23-6	7"	9.5	3.17	3.23	1.37	4.0	4.0	2.0	8.0	Q3
SOIC-8	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP-8	13"	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
SOIC-14	13"	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP-14	13"	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1

DD00001

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7" (Option)	368	227	224	8
7"	442	410	224	18
13"	386	280	370	5

DD00002