



SGM8521/2/4

150kHz, 5.5µA, Rail-to-Rail I/O CMOS Operational Amplifiers

PRODUCT DESCRIPTION

The SGM8521 (single), SGM8522 (dual) and SGM8524 (quad) are low cost, rail-to-rail input and output voltage feedback amplifiers. They have a wide input common mode voltage range and output voltage swing, and take the minimum operating supply voltage down to 2.1V. The maximum recommended supply voltage is 5.5V. All are specified over the extended -40°C to +125°C temperature range.

The SGM8521/2/4 provide 150kHz bandwidth at a low current consumption of 5.5µA per amplifier. Very low input bias currents enable the SGM8521/2/4 to be used for integrators, photodiode amplifiers, and piezoelectric sensors. Rail-to-rail input and output are useful to designers for buffering ASIC in single-supply systems.

Applications for these amplifiers include safety monitoring, portable equipment, battery and power supply control, and signal conditioning and interfacing for transducers in very low power systems.

The SGM8521 single is available in Green SOT-23-5 and SOIC-8 packages. The SGM8522 dual comes in Green SOIC-8 and MSOP-8 packages. The SGM8524 quad is offered in Green SOIC-14 and TSSOP-14 packages.

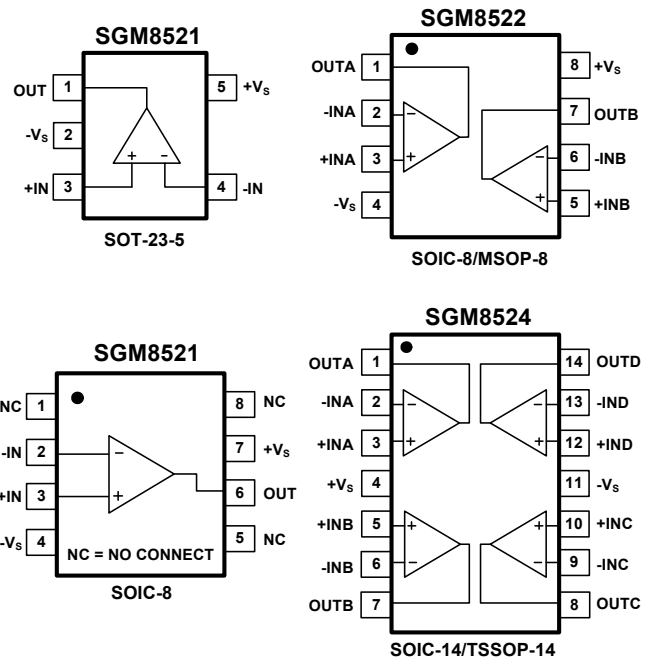
APPLICATIONS

- ASIC Input or Output Amplifier
- Sensor Interface
- Piezoelectric Transducer Amplifier
- Medical Instrumentation
- Mobile Communication
- Audio Output
- Portable Systems
- Smoke Detectors
- Mobile Telephone
- Notebook PC
- PCMCIA Cards
- Battery-Powered Equipment

FEATURES

- Low Cost
- Rail-to-Rail Input and Output
1mV Typical V_{OS}
- Unity Gain Stable
- Gain-Bandwidth Product: 150kHz
- Supply Voltage Range: 2.1V to 5.5V
- Input Voltage Range:
-0.1V to +5.6V with $V_S = 5.5V$
- Low Supply Current: 5.5µA/Amplifier
- Small Packaging
SGM8521 Available in SOIC-8 and SOT-23-5
SGM8522 Available in SOIC-8 and MSOP-8
SGM8524 Available in SOIC-14 and TSSOP-14

PIN CONFIGURATIONS (TOP VIEW)



PACKAGE/ORDERING INFORMATION

MODEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
SGM8521	SGM8521XN5/TR	SOT-23-5	Tape and Reel, 3000	8521
	SGM8521XS/TR	SOIC-8	Tape and Reel, 2500	SGM8521XS
SGM8522	SGM8522XS/TR	SOIC-8	Tape and Reel, 2500	SGM8522XS
	SGM8522XMS/TR	MSOP-8	Tape and Reel, 3000	SGM8522XMS
SGM8524	SGM8524XS14/TR	SOIC-14	Tape and Reel, 2500	SGM8524XS14
	SGM8524XTS14/TR	TSSOP-14	Tape and Reel, 3000	SGM8524XTS14

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, +V _S to -V _S	6V	SOIC-8, θ_{JA}	125°C/W
Common Mode Input Voltage	(-V _S) - 0.3V to (+V _S) + 0.3V	MSOP-8, θ_{JA}	216°C/W
Storage Temperature Range.....	-65°C to +150°C	Lead Temperature (Soldering 10sec).....	260°C
Junction Temperature	150°C	ESD Susceptibility	
Operating Temperature Range.....	-40°C to +125°C	HBM.....	4000V
Package Thermal Resistance @ T _A = +25°C		MM.....	400V
SOT-23-5, θ_{JA}	190°C/W		

NOTE:

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications 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 latest datasheet.

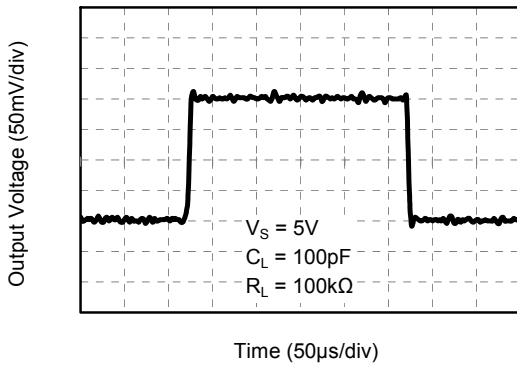
ELECTRICAL CHARACTERISTICS(At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, $R_L = 500\text{k}\Omega$ connected to $V_S/2$ and $V_{OUT} = V_S/2$, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{OS}			1	3.5	mV
Quiescent Current/Amplifier	I_Q			5.5		μA
Open-Loop Voltage Gain	G_V	$V_O = +0.015\text{V}$ to $+4.985\text{V}$, $R_L = 500\text{k}\Omega$	90	110		dB
		$V_O = +0.1\text{V}$ to $+4.9\text{V}$, $R_L = 100\text{k}\Omega$	88	108		
Common Mode Rejection Ratio	CMRR	$V_S = +5.5\text{V}$, $-0.1\text{V} < V_{CM} < +5.6\text{V}$	60	87		dB
		$V_S = +5.5\text{V}$, $-0.1\text{V} < V_{CM} < +4\text{V}$	70	114		
Power Supply Rejection Ratio	PSRR	$V_S = +2.5\text{V}$ to $+5.5\text{V}$, $V_{CM} = +0.5\text{V}$	65	94		dB
Output Current	I_{SOURCE}	$R_L = 10\Omega$ to $V_S/2$	61	87		mA
	I_{SINK}		60	76		
Output Voltage Swing	V_{OH}		4.990	4.997		V
	V_{OL}			0.005	0.010	
Gain-Bandwidth Product	GBP			150		kHz
Slew Rate	SR	$R_L = 100\text{k}\Omega$		0.05		$\text{V}/\mu\text{s}$
Voltage Noise Density	e_n	$f = 1\text{kHz}$		85		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 10\text{kHz}$		44		

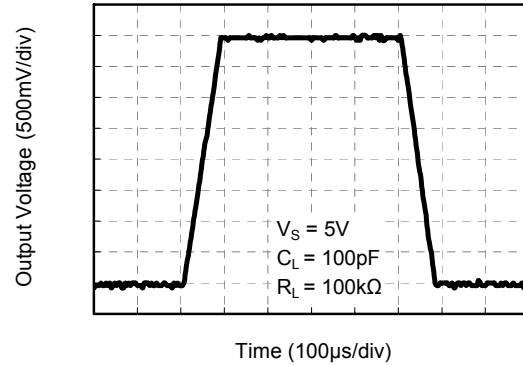
TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$ and $R_L = 500\text{k}\Omega$ connected to $V_S/2$, unless otherwise noted.

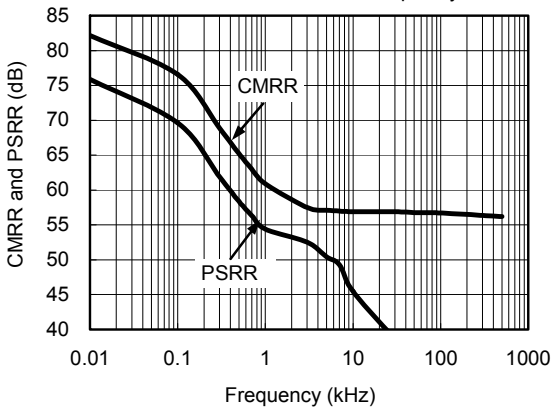
Small Signal Step Response



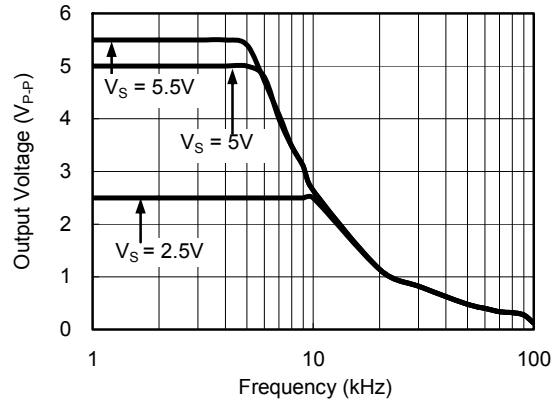
Large Signal Step Response



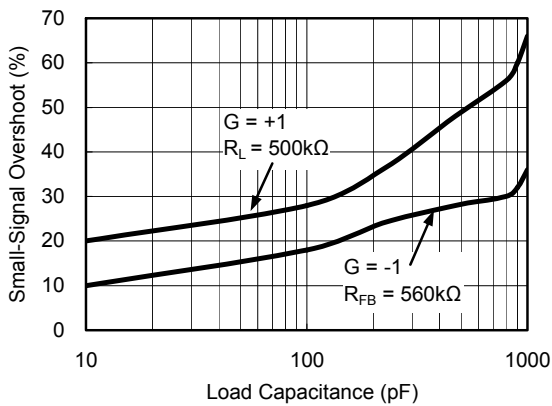
CMRR and PSRR vs. Frequency



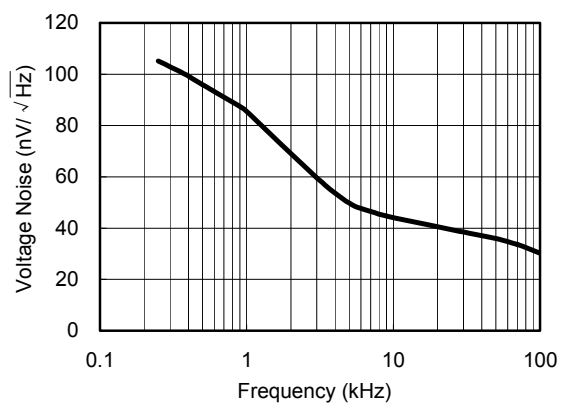
Maximum Output Voltage vs. Frequency



Small-Signal Overshoot vs. Load Capacitance

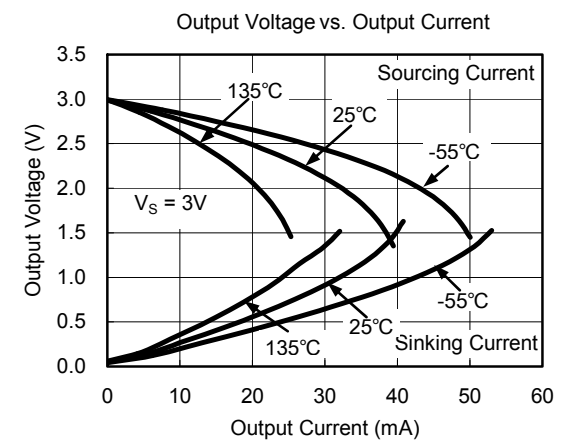
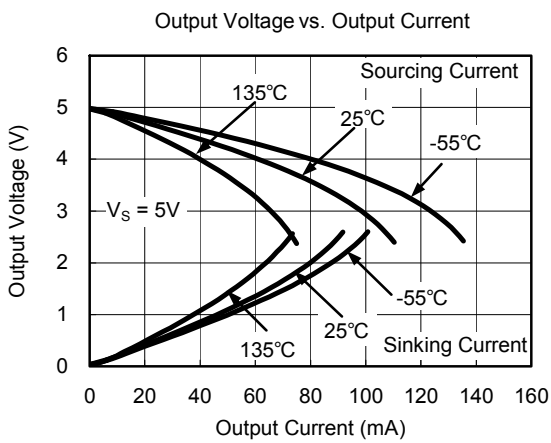
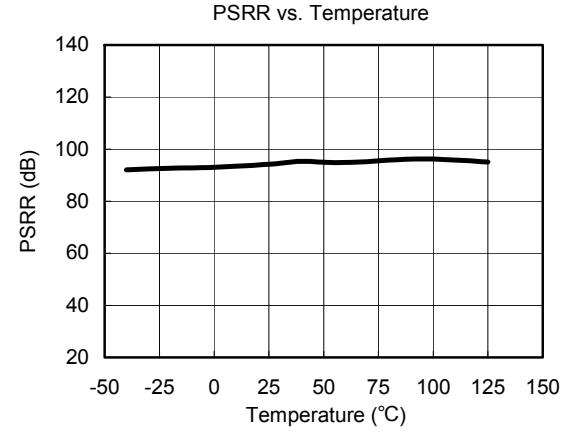
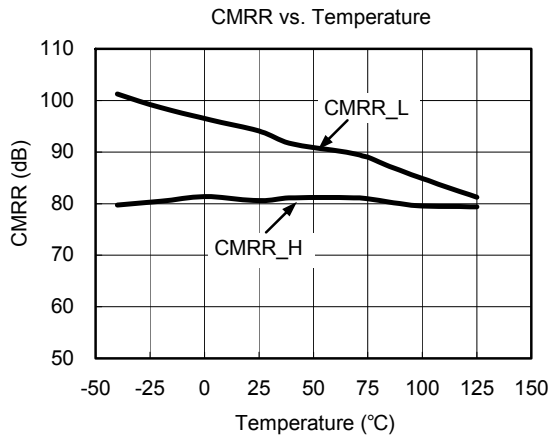
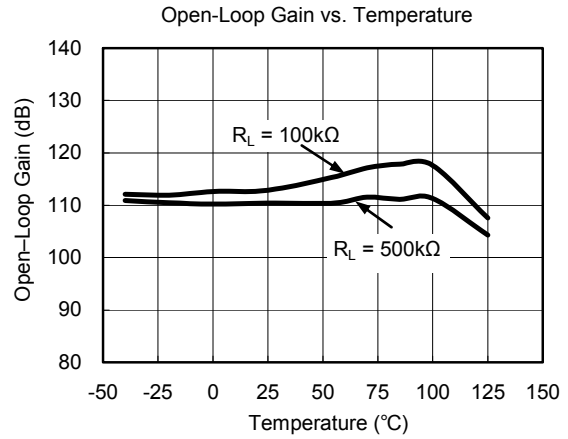
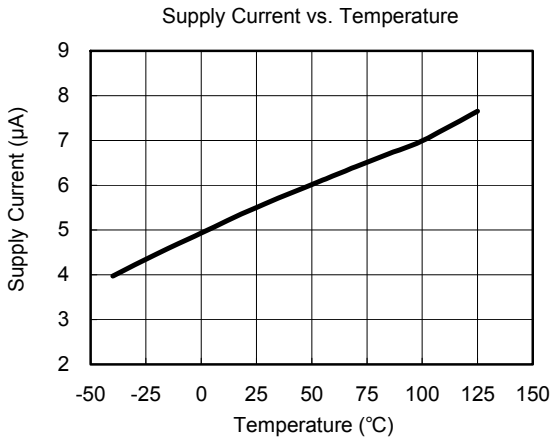


Input Voltage Noise Spectral Density vs. Frequency



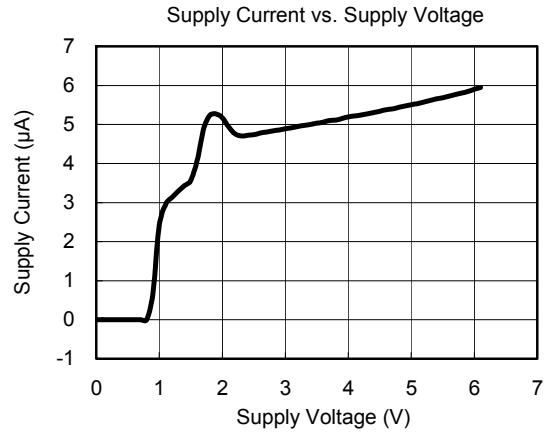
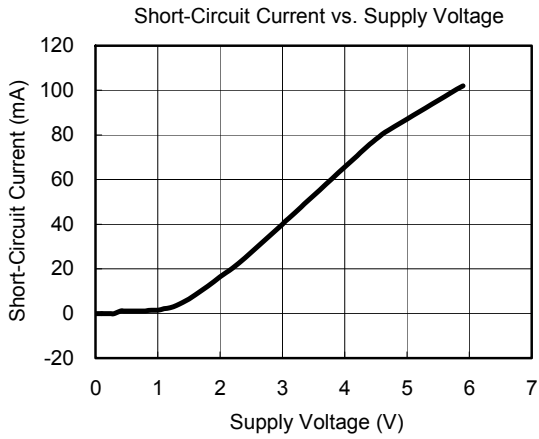
TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, and $R_L = 500\text{k}\Omega$ connected to $V_S/2$, unless otherwise noted.



TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, and $R_L = 500\text{k}\Omega$ connected to $V_S/2$, unless otherwise noted.



APPLICATION NOTES

Driving Capacitive Loads

The SGM8521/2/4 can directly drive 250pF in unity-gain without oscillation. The unity-gain follower (buffer) is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers and this results in ringing or even oscillation. Applications that require greater capacitive driving capability should use an isolation resistor between the output and the capacitive load like the circuit in Figure 1. The isolation resistor R_{ISO} and the load capacitor C_L form a zero to increase stability. The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. Note that this method results in a loss of gain accuracy because R_{ISO} forms a voltage divider with the R_{LOAD} .

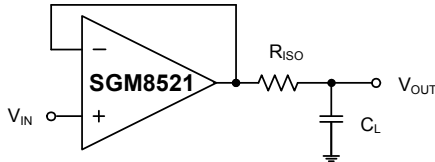


Figure 1. Indirectly Driving Heavy Capacitive Load

An improved circuit is shown in Figure 2. It provides DC accuracy as well as AC stability. R_F provides the DC accuracy by connecting the inverting signal with the output. 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 phase margin in the overall feedback loop.

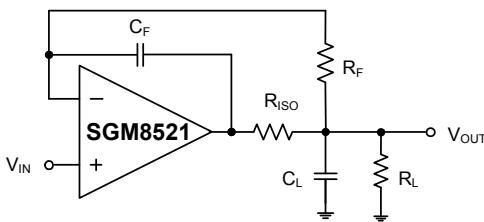


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

For non-buffer configuration, there are two other ways to increase the phase margin: (a) by increasing the amplifier's gain or (b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node.

Power-Supply Bypassing and Layout

The SGM8521/2/4 family operates from either a single +2.1V to +5.5V supply or dual $\pm 1.05V$ to $\pm 2.75V$ supplies. For single-supply operation, bypass the power supply $+V_S$ with a 0.1µF 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 0.1µF ceramic capacitors. 2.2µF tantalum capacitor can be added for better performance.

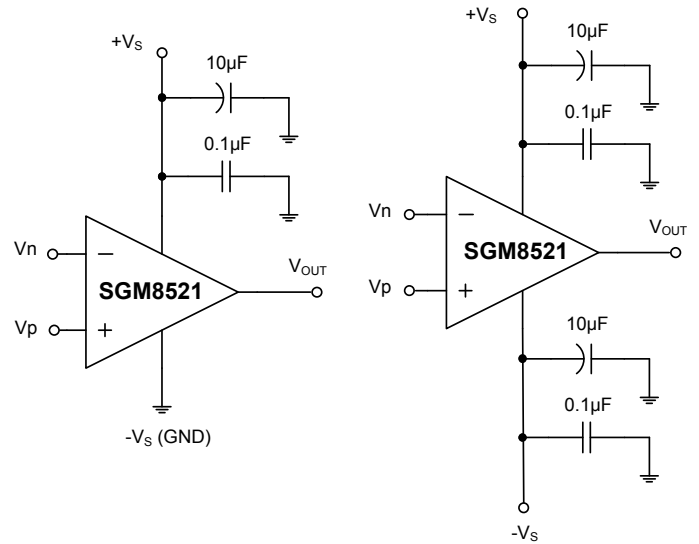


Figure 3. Amplifier with Bypass Capacitors

TYPICAL APPLICATION CIRCUITS

Differential Amplifier

The circuit shown in Figure 4 performs the difference function. If the resistor ratios are equal to ($R4/R3 = R2/R1$), then $V_{OUT} = (Vp - Vn) \times R2/R1 + V_{REF}$.

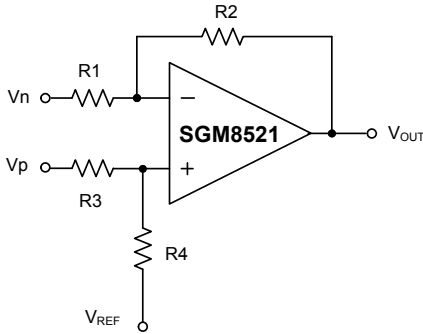


Figure 4. Differential Amplifier

Instrumentation Amplifier

The circuit in Figure 5 performs the same function as that in Figure 4 but with a high input impedance.

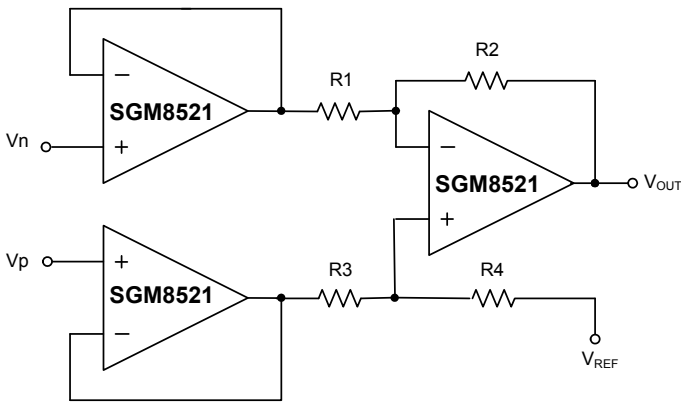


Figure 5. Instrumentation Amplifier

Low Pass Active Filter

The low pass filter shown in Figure 6 has a DC gain of $(-R2/R1)$ and the -3dB corner frequency is $1/2\pi R2C$. Make sure the filter bandwidth 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 resistor values as low as possible and consistent with output loading consideration.

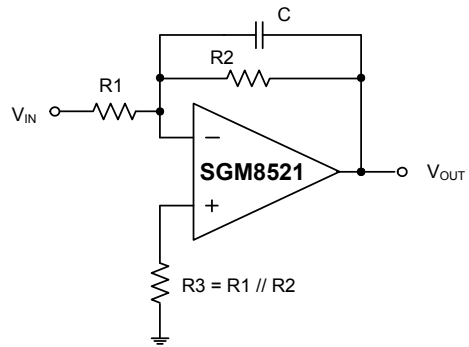
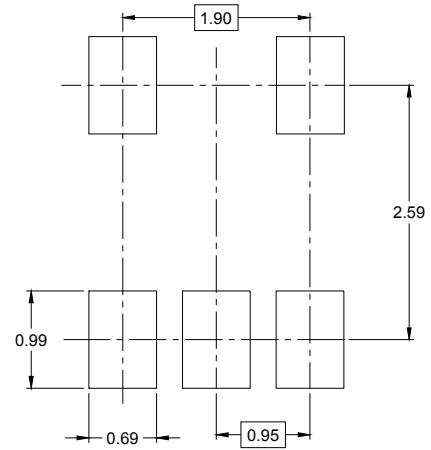
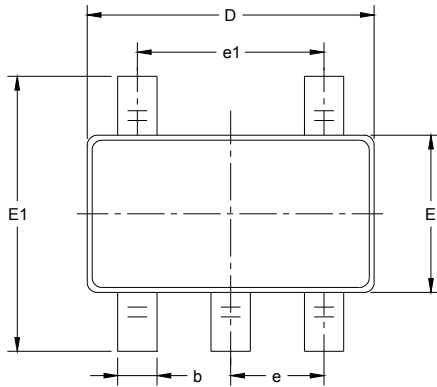


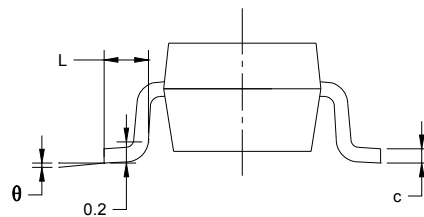
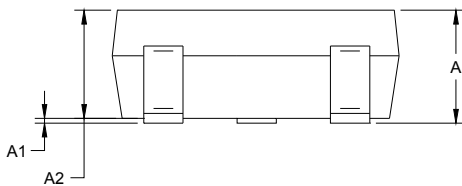
Figure 6. Low Pass Active Filter

PACKAGE OUTLINE DIMENSIONS

SOT-23-5



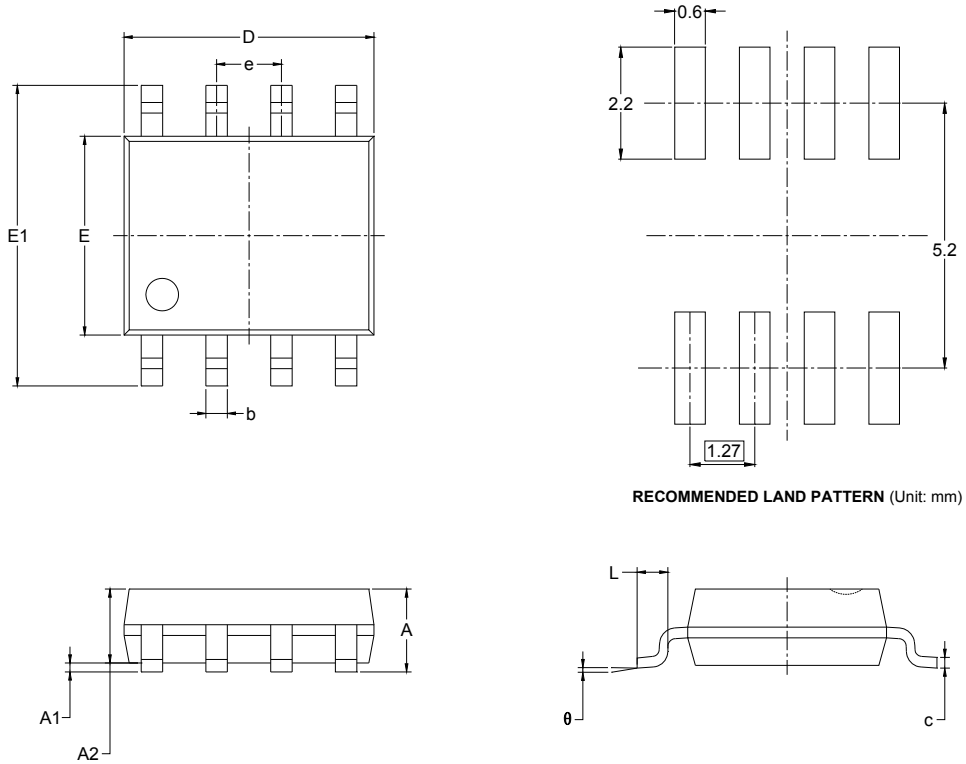
RECOMMENDED LAND PATTERN (Unit: mm)



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

SOIC-8

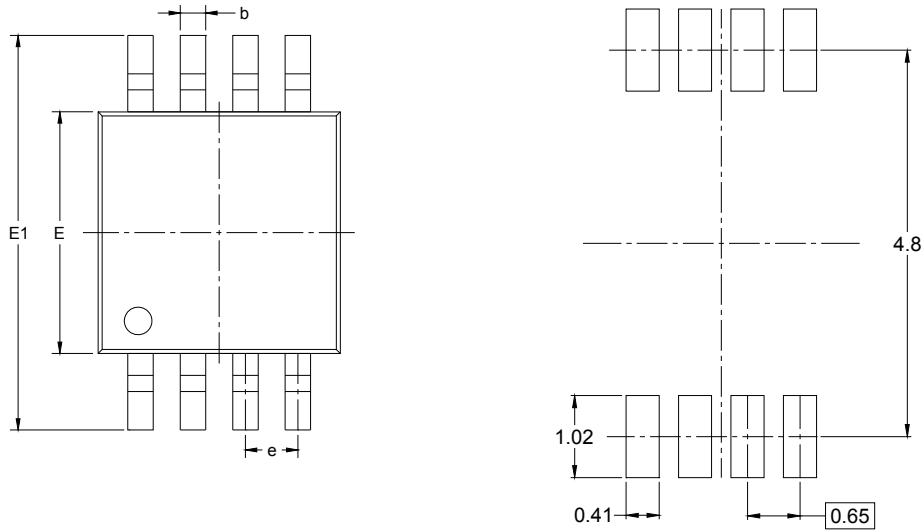


RECOMMENDED LAND PATTERN (Unit: mm)

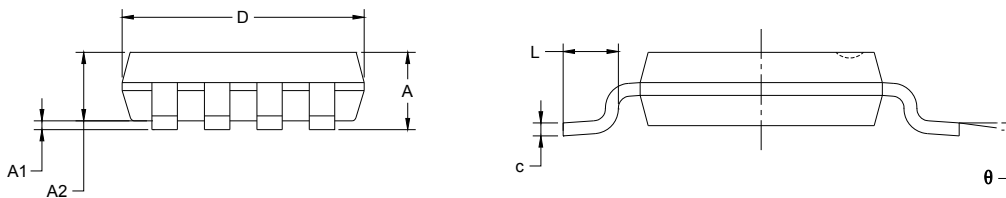
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

PACKAGE OUTLINE DIMENSIONS

MSOP-8



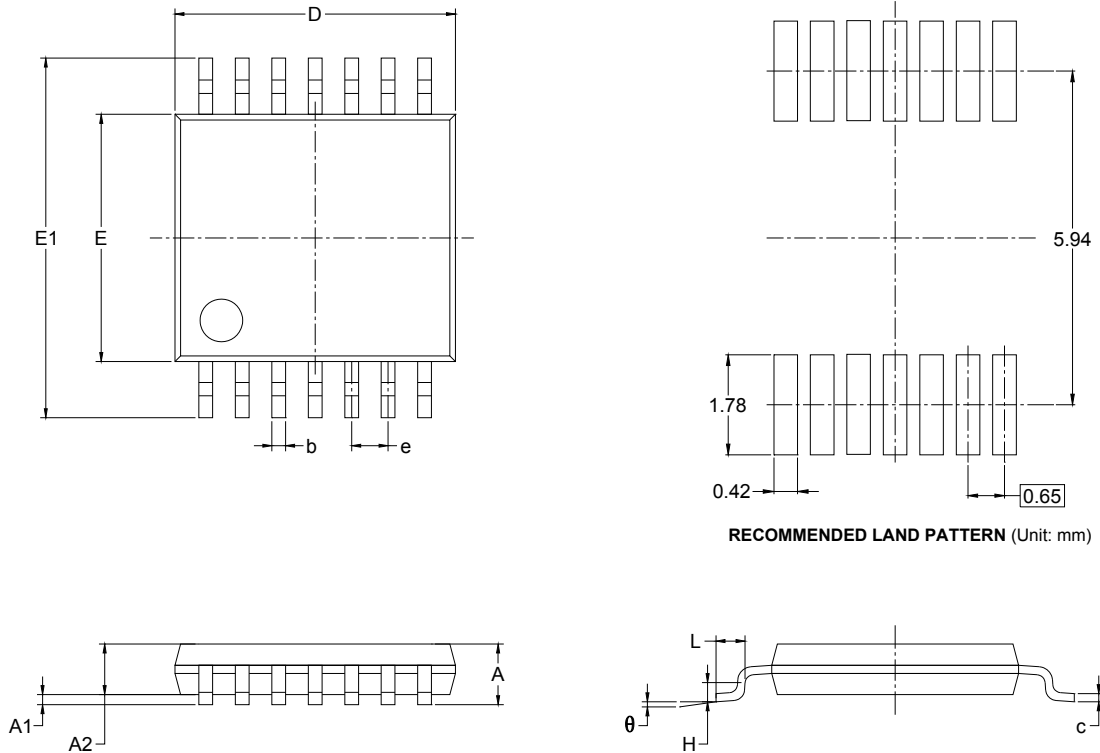
RECOMMENDED LAND PATTERN (Unit: mm)



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 OUTLINE DIMENSIONS

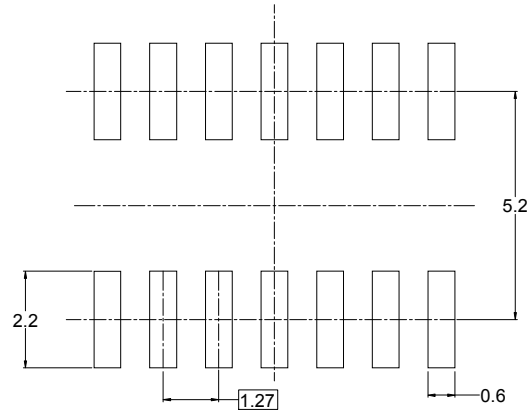
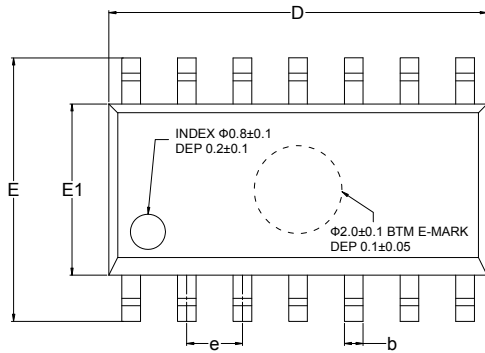
TSSOP-14



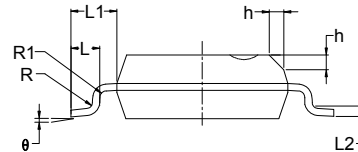
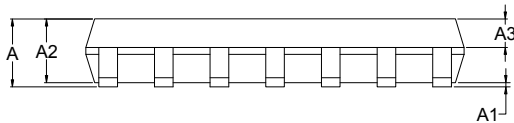
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.100		0.043
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500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

PACKAGE OUTLINE DIMENSIONS

SOIC-14



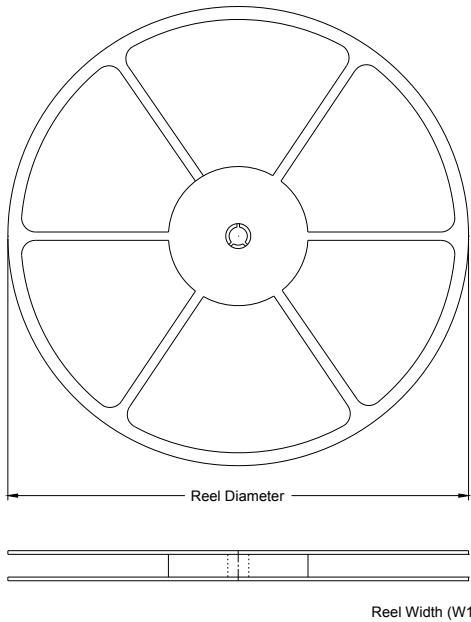
RECOMMENDED LAND PATTERN (Unit: mm)



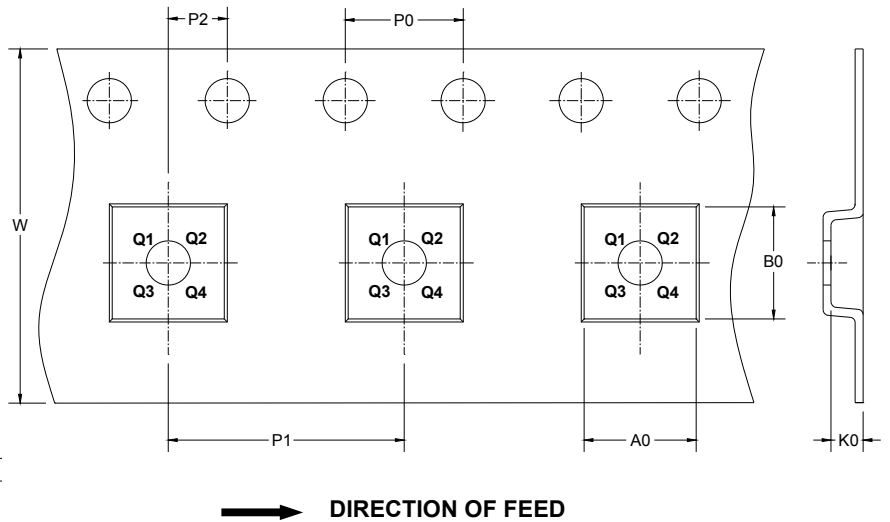
Symbol	Dimensions In Millimeters			Dimensions In Inches		
	MIN	MOD	MAX	MIN	MOD	MAX
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
A2	1.25		1.65	0.049		0.065
A3	0.55		0.75	0.022		0.030
b	0.36		0.49	0.014		0.019
D	8.53		8.73	0.336		0.344
E	5.80		6.20	0.228		0.244
E1	3.80		4.00	0.150		0.157
e	1.27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

TAPE AND REEL INFORMATION

REEL DIMENSIONS



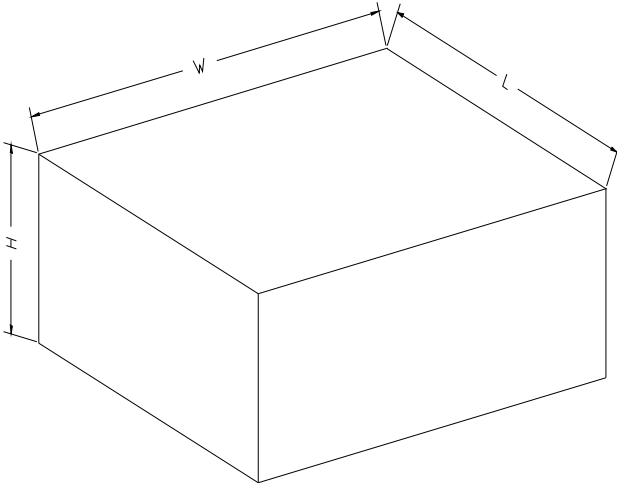
TAPE DIMENSIONS



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	3.17	3.23	1.37	4.0	4.0	2.0	8.0	Q3
SOIC-8	13"	12.4	6.4	5.4	2.1	4.0	8.0	2.0	12.0	Q1
MSOP-8	13"	12.4	5.2	3.3	1.5	4.0	8.0	2.0	12.0	Q1
SOIC-14	13"	16.4	6.6	9.3	2.1	4.0	8.0	2.0	16.0	Q1
TSSOP-14	13"	12.4	6.95	5.6	1.2	4.0	8.0	2.0	12.0	Q1

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