SGM321XC5
1MHz, 60µA, Rail-to-Rail I/O CMOS Operational Amplifier

GENERAL DESCRIPTION

The SGM321XC5 is a single, low cost, voltage feedback amplifier. The device can operate from 2.1V to 5.5V single supply, while consuming only 60µA quiescent current. It provides rail-to-rail input with a wide input common mode voltage range and rail-to-rail output voltage swing. This feature makes SGM321XC5 appropriate for buffering ASIC.

The SGM321XC5 offers a gain-bandwidth product of 1MHz and an ultra-low input bias current of 10pA. It is well suited for piezoelectric sensors, integrators and photodiode amplifiers.

The SGM321XC5 is designed into a wide range of applications, such as battery-powered instrumentation, safety monitoring, portable systems, and transducer interface circuits in low power systems.

The SGM321XC5 is available in a Green SC70-5 package. It is specified over the extended -40℃ to +125℃ temperature range.

FEATURES

- **Low Cost**
- **Input Offset Voltage: 5mV (MAX)**
- **Ultra-Low Input Bias Current: 10pA**
- **Unity-Gain Stable**
- **Gain-Bandwidth Product: 1MHz**
- **Rail-to-Rail Input and Output**
- **Supply Voltage Range: 2.1V to 5.5V**
- **Input Voltage Range: -0.1V to 5.6V with V_S = 5.5V**
- **Low Supply Current: 60µA**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in a Green SC70-5 Package**

APPLICATIONS

ASIC Input or Output Amplifiers
Piezoelectric Transducer Amplifiers
Battery-Powered Equipment
Portable Equipment
Sensor Interfaces
Medical Instrumentation
Mobile Communications
Audio Outputs
Smoke Detectors
Notebook PCs
PCMCIA Cards
DSP Interfaces

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM321XC5	SC70-5	-40℃ to +125℃	SGM321XC5/TR	321	Tape and Reel, 3000

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.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $+V_S$ to $-V_S$.......6V
Input Common Mode Voltage Range
.... $(-V_S)$ - 0.3V to $(+V_S)$ + 0.3V
Package Thermal Resistance @ T_A = +25℃
SC70-5, θ_{JA}....... 333℃/W
Junction Temperature.......+150℃
Storage Temperature Range.......-65℃ to +150℃
Lead Temperature (Soldering, 10s).......+260℃
ESD Susceptibility
HBM.......4000V
MM.......400V

RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range.......-40℃ to +125℃

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

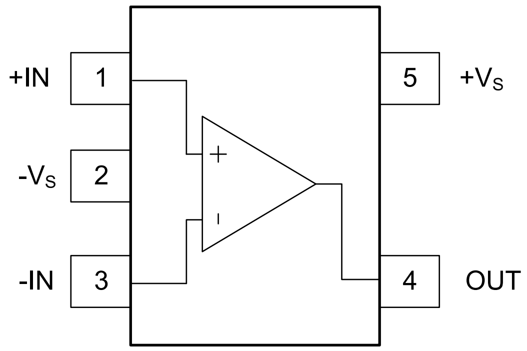
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

DISCLAIMER

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

PIN CONFIGURATION

(TOP VIEW)



SC70-5

ELECTRICAL CHARACTERISTICS

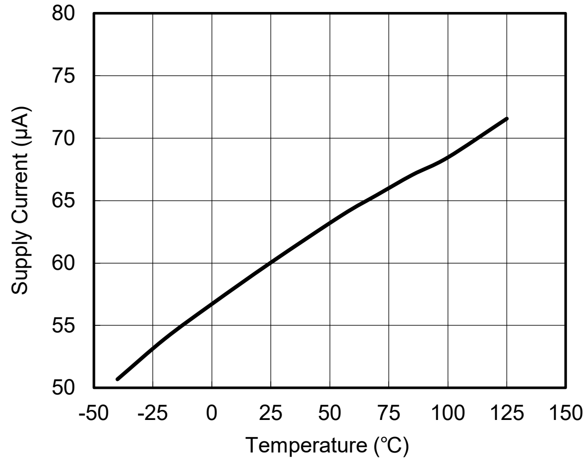
(At V_S = 5V, R_L = 100kΩ connected to V_S/2, and V_{OUT} = V_S/2, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	SGM321XC5 TYP +25℃	MIN/MAX OVER TEMPERATURE +25℃	-40℃ to +125℃	UNITS	MIN/MAX
Input Characteristics							
Input Offset Voltage	V_{OS}	V_{CM} = V_S/2	0.8	5	6	mV	MAX
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		2.7			μV/℃	TYP
Input Bias Current	I_B		10			pA	TYP
Input Offset Current	I_{OS}		10			pA	TYP
Input Common Mode Voltage Range	V_{CM}	V_S = 5.5V	-0.1 to 5.6			V	TYP
Common Mode Rejection Ratio	CMRR	V_S = 5.5V, V_{CM} = -0.1V to 4V	70	62	60	dB	MIN
		V_S = 5.5V, V_{CM} = -0.1V to 5.6V	68	56	53		
Open-Loop Voltage Gain	A_{OL}	R_L = 5kΩ, V_{OUT} = 0.1V to 4.9V	80	70	68	dB	MIN
		R_L = 100kΩ, V_{OUT} = 0.035V to 4.965V	84	80	72		
Output Characteristics							
Output Voltage Swing from Rail	V_{OH}	R_L = 100kΩ	4.997	4.980	4.960	V	MIN
	V_{OL}	R_L = 100kΩ	5	20	40	mV	MAX
	V_{OH}	R_L = 10kΩ	4.992	4.970	4.950	V	MIN
	V_{OL}	R_L = 10kΩ	8	30	50	mV	MAX
Output Current	I_{SOURCE}	R_L = 10Ω to V_S/2	84	60	40	mA	MIN
	I_{SINK}		75	60	40		
Power Supply							
Operating Voltage Range				2.1	2.5	V	MIN
				5.5	5.5	V	MAX
Power Supply Rejection Ratio	PSRR	V_S = 2.5V to 5.5V, V_{CM} = 0.5V	82	60	56	dB	MIN
Quiescent Current	I_Q		60	80	84	μA	MAX
Dynamic Performance (C_L = 100pF)							
Gain-Bandwidth Product	GBP		1			MHz	TYP
Slew Rate	SR	G = +1, 2V Output Step	0.52			V/μs	TYP
Settling Time to 0.1%	t_S	G = +1, 2V Output Step	5.3			μs	TYP
Overload Recovery Time		$V_{IN}\cdot G = V_S$	2.6			μs	TYP
Noise Performance							
Input Voltage Noise Density	e_n	f = 1kHz	27			nV/$\sqrt{Hz}$	TYP
		f = 10kHz	20			nV/$\sqrt{Hz}$	TYP

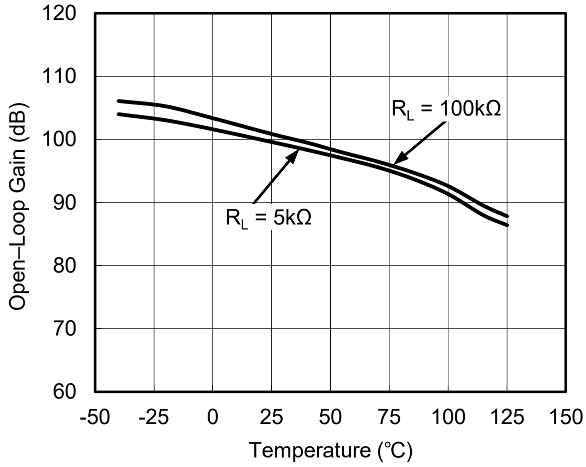
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_S = 5V, and R_L = 100kΩ connected to V_S/2, unless otherwise noted.

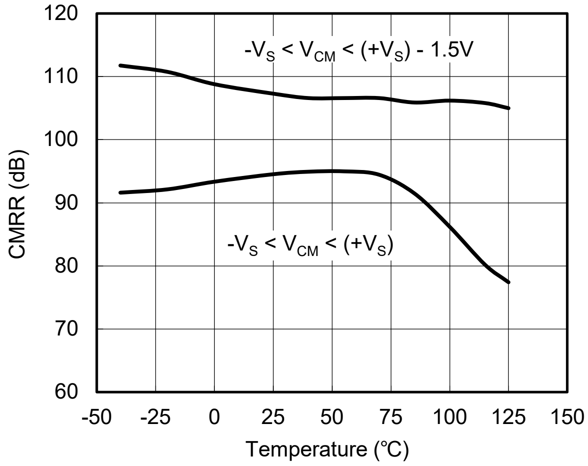
Supply Current vs. Temperature



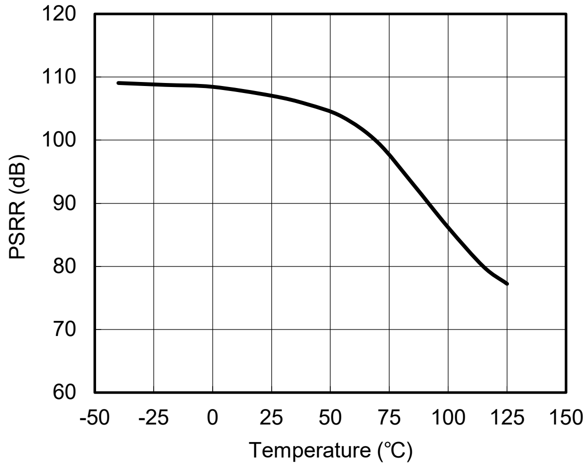
Open-Loop Gain vs. Temperature



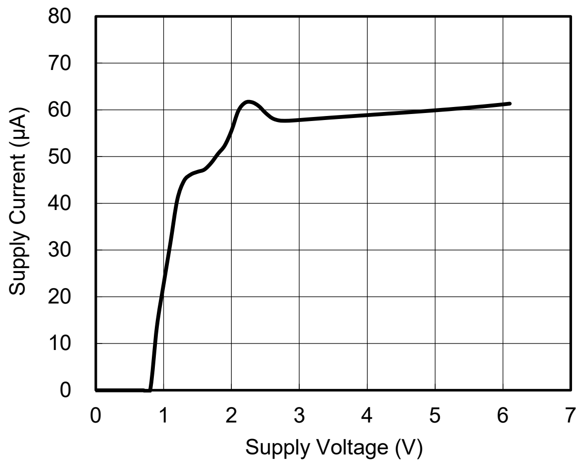
Common Mode Rejection Ratio vs. Temperature



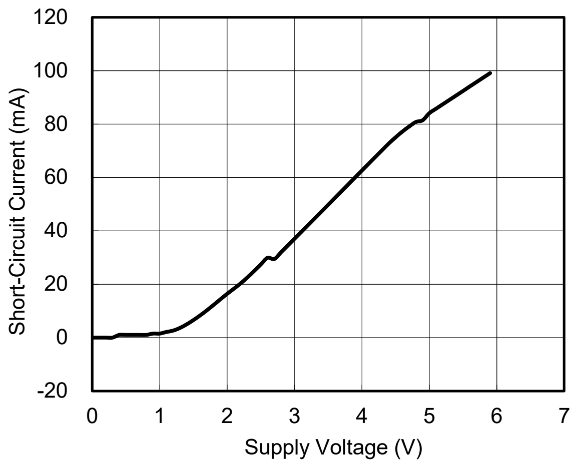
Power Supply Rejection Ratio vs. Temperature



Supply Current vs. Supply Voltage

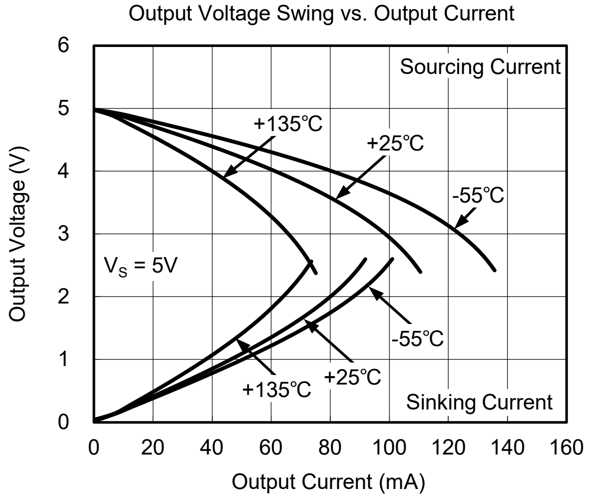


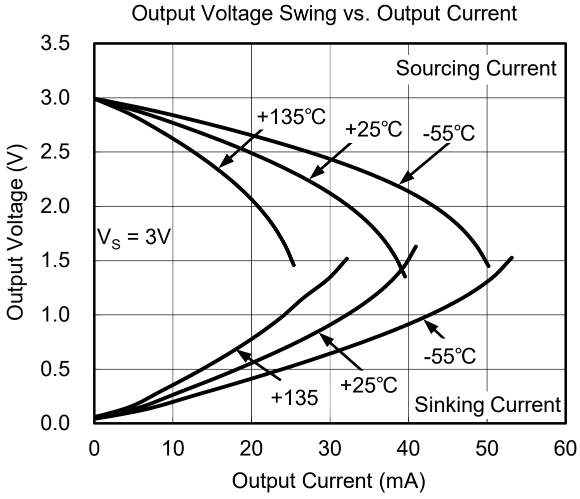
Short-Circuit Current vs. Supply Voltage

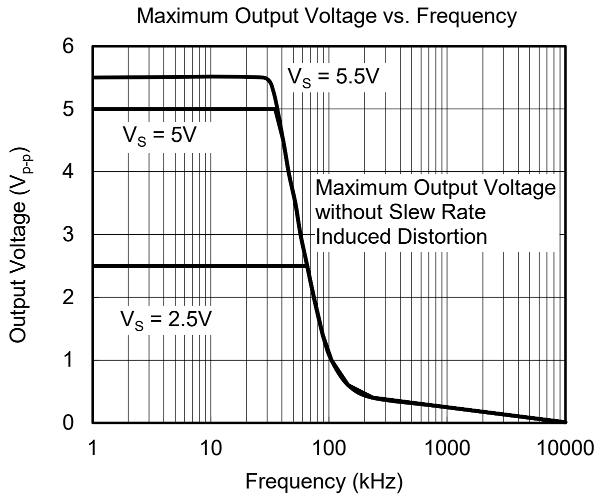


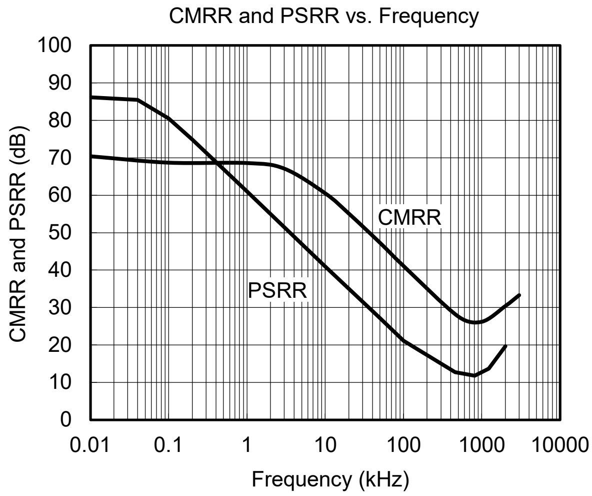
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

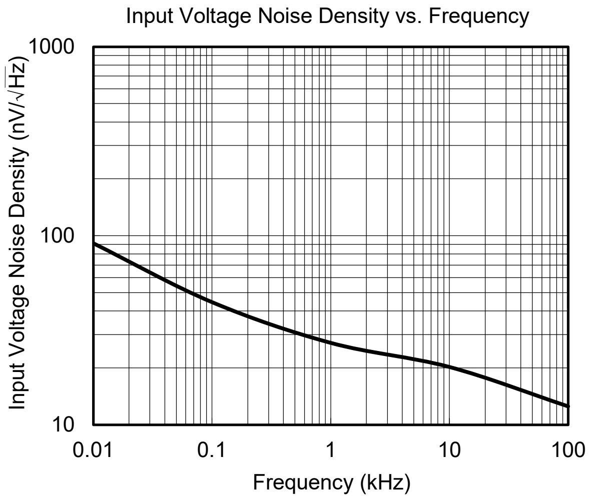
At T_A = +25℃, V_S = 5V, and R_L = 100kΩ connected to V_S/2, unless otherwise noted.

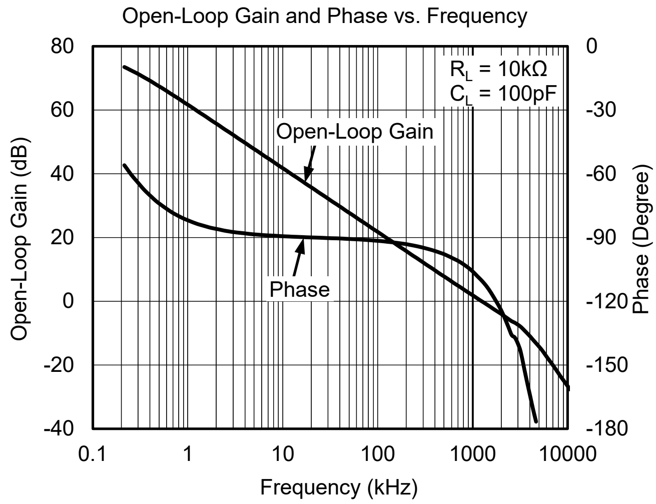








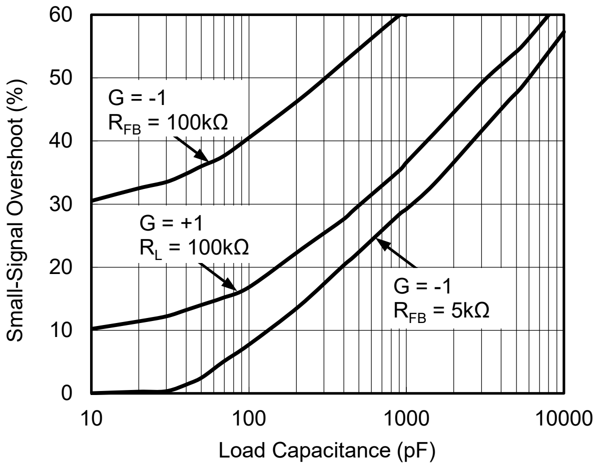




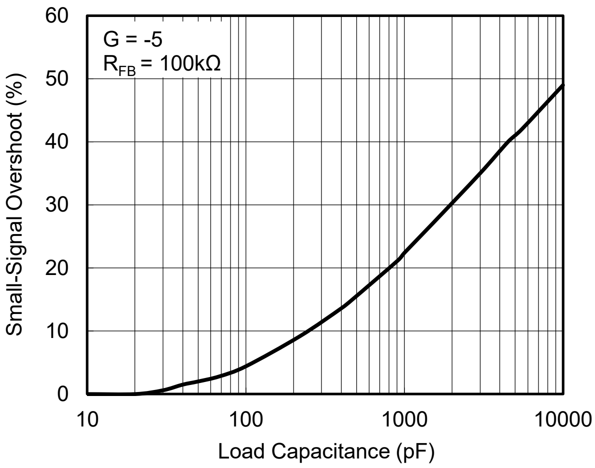
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, and R_L = 100kΩ connected to V_S/2, unless otherwise noted.

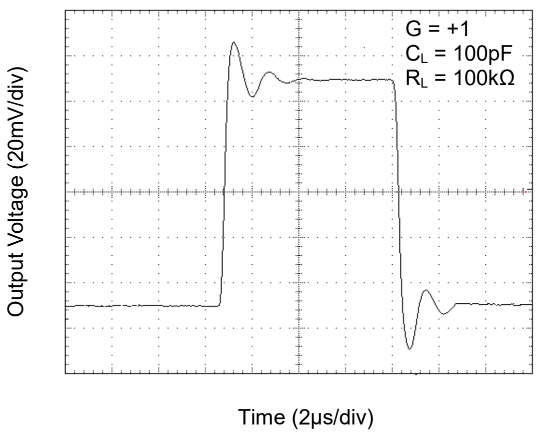
Small-Signal Overshoot vs. Load Capacitance



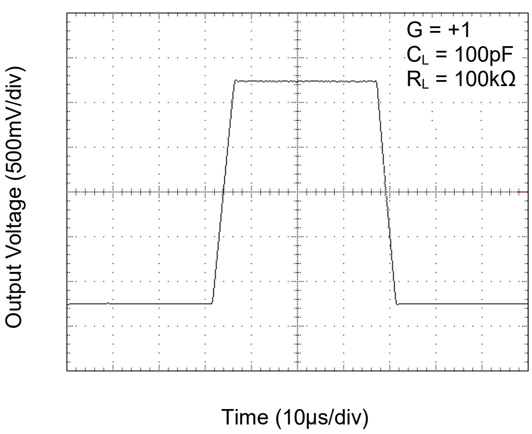
Small-Signal Overshoot vs. Load Capacitance



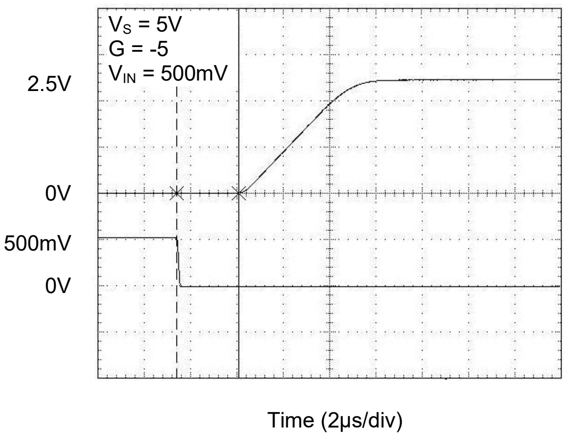
Small-Signal Step Response



Large-Signal Step Response



Overload Recovery Time



APPLICATION INFORMATION

Rail-to-Rail Input

When SGM321XC5 works at the power supply between 2.1V and 5.5V, the input common mode voltage range is from ($-V_S$) - 0.1V to ($+V_S$) + 0.1V. In Figure 1, the ESD diodes between the inputs and the power supply rails will clamp the input voltage not to exceed the rails.

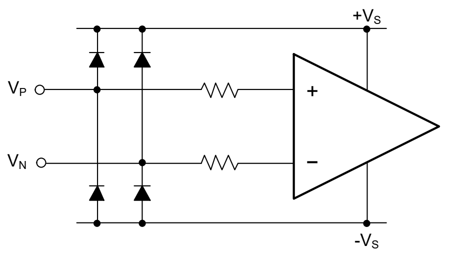


Figure 1. Input Equivalent Circuit

Rail-to-Rail Output

The SGM321XC5 supports rail-to-rail output operation. In single power supply application, for example, when $+V_S$ = 5V, $-V_S$ = GND, 100kΩ load resistor is tied from OUT pin to $V_S/2$, the typical output swing range is from 0.005V to 4.997V.

Driving Capacitive Loads

The SGM321XC5 is designed for unity-gain stable for capacitive load up to 250pF. If greater capacitive load must be driven in application, the circuit in Figure 2 can be used. In this circuit, the IR drop voltage generated by R_{ISO} is compensated by feedback loop.

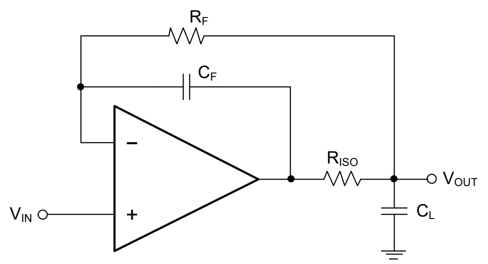


Figure 2. Circuit to Drive Heavy Capacitive Load

Power Supply Decoupling and Layout

A clean and low noise power supply is very important in amplifier circuit design, besides of input signal noise, the power supply is one of important source of noise to the amplifiers through $+V_S$ and $-V_S$ pins. Power supply bypassing is an effective method to clear up the noise at power supply, and the low impedance path to ground of decoupling capacitor will bypass the noise to GND. In application, 10µF ceramic capacitor paralleled with 0.1µF or 0.01µF ceramic capacitor is used in Figure 3. The ceramic capacitors should be placed as close as possible to $+V_S$ and $-V_S$ power supply pins.

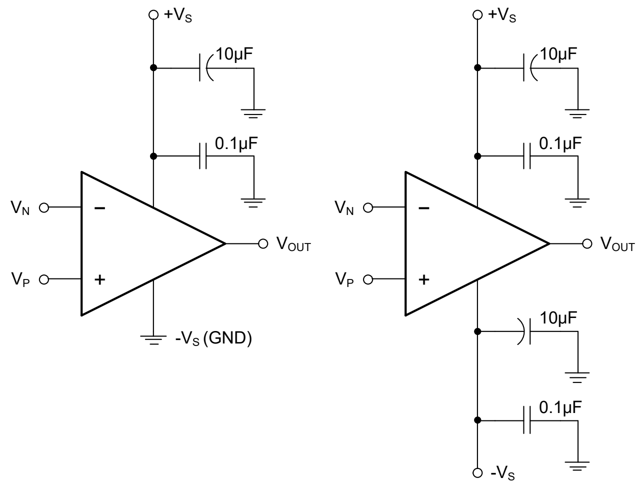


Figure 3. Amplifier Power Supply Bypassing

APPLICATION INFORMATION (continued)

Typical Application Circuits

Difference Amplifier

The circuit in Figure 4 is a design example of classical difference amplifier. If $R_4/R_3 = R_2/R_1$, then $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$.

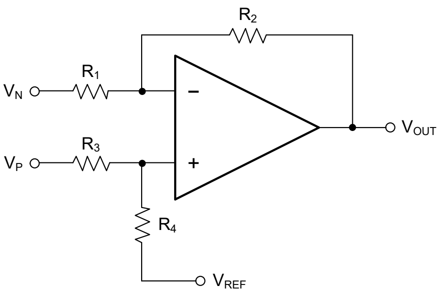


Figure 4. Difference Amplifier

High Input Impedance Difference Amplifier

The circuit in Figure 5 is a design example of high input impedance difference amplifier, the added amplifiers at the input are used to increase the input impedance and eliminate drawback of low input impedance in Figure 4.

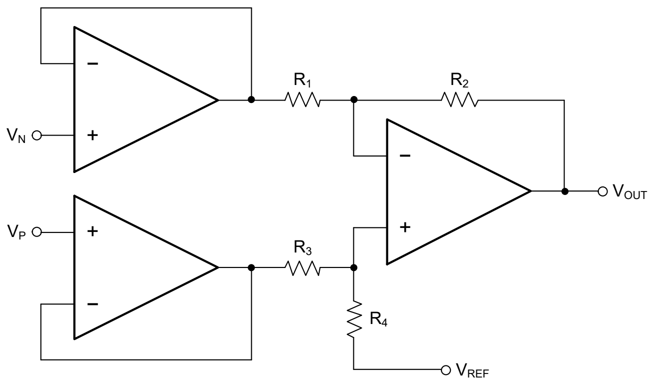


Figure 5. High Input Impedance Difference Amplifier

Active Low-Pass Filter

The circuit in Figure 6 is a design example of active low-pass filter, the DC gain is equal to $-R_2/R_1$ and the -3dB corner frequency is equal to $1/2\pi R_2C$. In this design, the filter bandwidth must be less than the bandwidth of the amplifier, the resistor values must be selected as low as possible to reduce ringing or oscillation generated by the parasitic parameters in PCB layout.

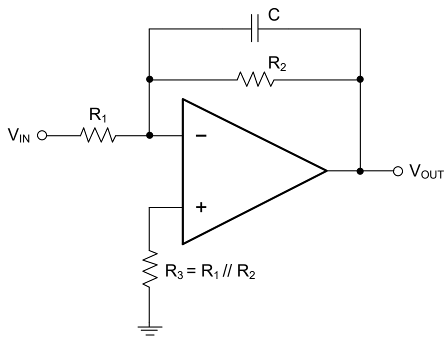
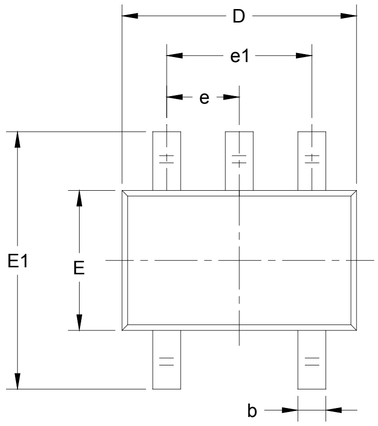
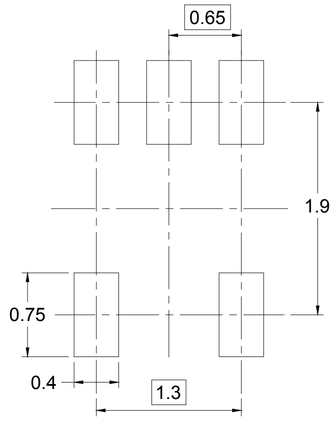


Figure 6. Active Low-Pass Filter

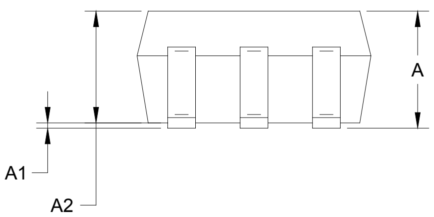
PACKAGE OUTLINE DIMENSIONS

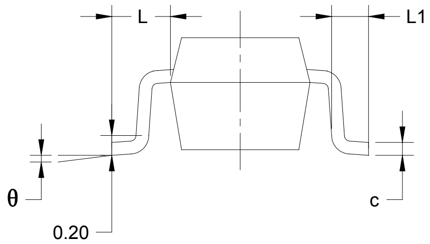
SC70-5





RECOMMENDED LAND PATTERN (Unit: mm)

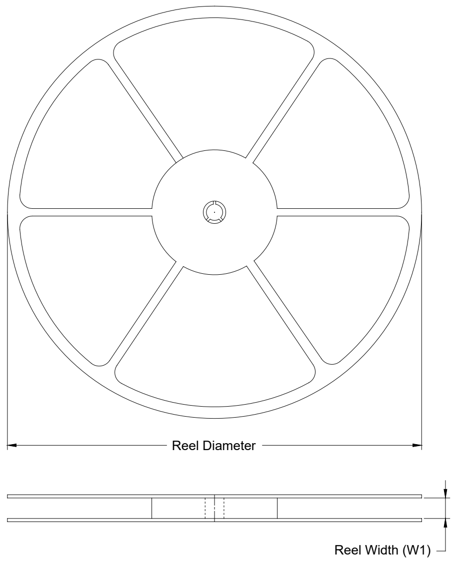




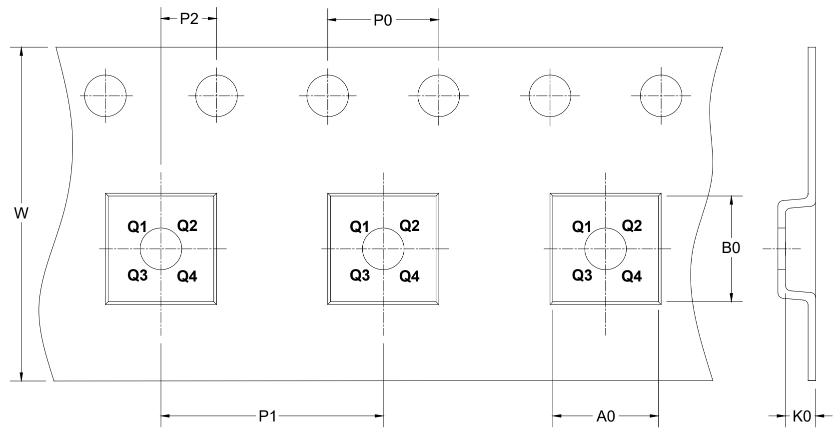
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026 TYP	
e1	1.300 BSC		0.051 BSC	
L	0.525 REF		0.021 REF	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

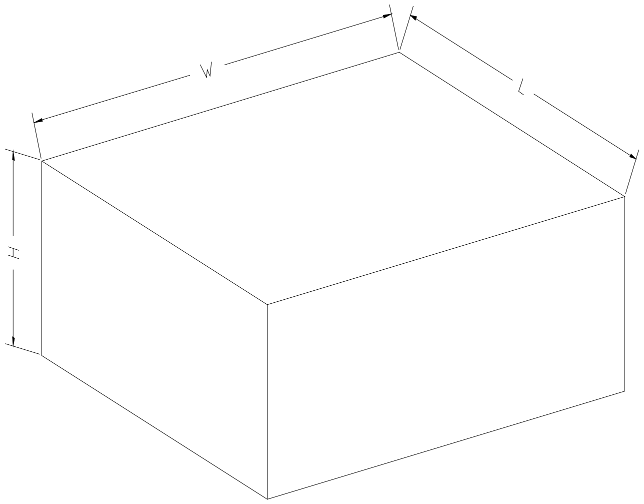
NOTE: The picture is only for reference. Please make the object as the standard.

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
SC70-5	7″	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q3

DD0001

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

DD0002