

SNA8331Q 350kHz Zero-Drift CMOS Rail-to-Rail IO Opamp with RF Filter

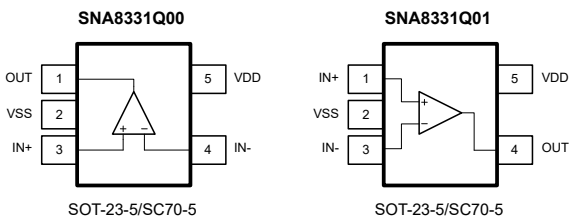
Features

- Single-Supply Operation from +1.8V ~ +5.5V
- Rail-to-Rail Input/Output
- Gain-Bandwidth Product: 350kHz(Typ@25°C)
- Low Input Bias Current: 20pA (Typ@25°C)
- Low Offset Voltage: 10μV (Max@25°C)
- Quiescent Current: 25μA per Amplifier (Typ)
- Operating Temperature: -45°C ~ +125°C
- Zero Drift: 0.01μV/°C (Typ)
- Embedded RF Anti-EMI Filter
- Small Package: Available in SOT-23-5 and SC70-5 Packages
- AEC-Q100 qualified

Applications

- Transducer Application
- Temperature Measurements
- Electronics Scales
- Handheld Test Equipment
- Battery-Powered Instrumentation

Pin Assignment



General Description

The SNA8331Q amplifier is single supply, micro-power, zero-drift CMOS operational amplifier, the amplifier offers bandwidth of 350kHz, rail-to-rail inputs and outputs, and single-supply operation from 1.8V to 5.5V.

The SNA8331Q uses chopper stabilized technique to provide very low offset voltage (less than 10μV maximum) and near zero drift over temperature. Low quiescent supply current of 25μA per amplifier and very low input bias current of 20pA make the devices an ideal choice for low offset, low power consumption and high impedance applications.

The SNA8331Q offers excellent CMRR without the crossover associated with traditional complementary input stages. This design results in superior performance for driving analog-to-digital converters (ADCs) without degradation of differential linearity.

The SNA8331Q is available in SOT-23-5 and SC70-5 packages. The extended temperature range of -45°C to +125°C over all supply voltages offers additional design flexibility.

Ordering Information

Model	Channel	Package	Ordering Number	Packing Option
SNA8331Q	Single	SC70-5	SNA8331Q00CE5	Tape and Reel,3000
		SOT-23-5	SNA8331Q00CB5	Tape and Reel,3000
		SC70-5	SNA8331Q01CE5	Tape and Reel,3000
		SOT-23-5	SNA8331Q01CB5	Tape and Reel,3000

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1 Specifications

1.1 Absolute Maximum Ratings

Parameter	Min	Max	Unit
Power Supply Voltage (V_{DD} to V_{SS})	-0.5	+7.5	V
Analog Input Voltage (IN+ or IN-)	$V_{SS}-0.5$	$V_{DD}+0.5$	V
PDB Input Voltage	$V_{SS}-0.5$	+7	V
Operating Temperature Range	-45	+125	°C
Junction Temperature	160		°C
Storage Temperature Range	-55	+150	°C
Lead Temperature (soldering, 10sec)	260		°C
Package Thermal Resistance, θ_{JA} ($T_A=+25^\circ\text{C}$)	SOT-23-5	190	°C/W
	SC70-5	333	°C/W
ESD	HBM	6000	V
	MM	400	V

! **Attention:** Stresses greater than 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 under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

1.2 Electrical Characteristics

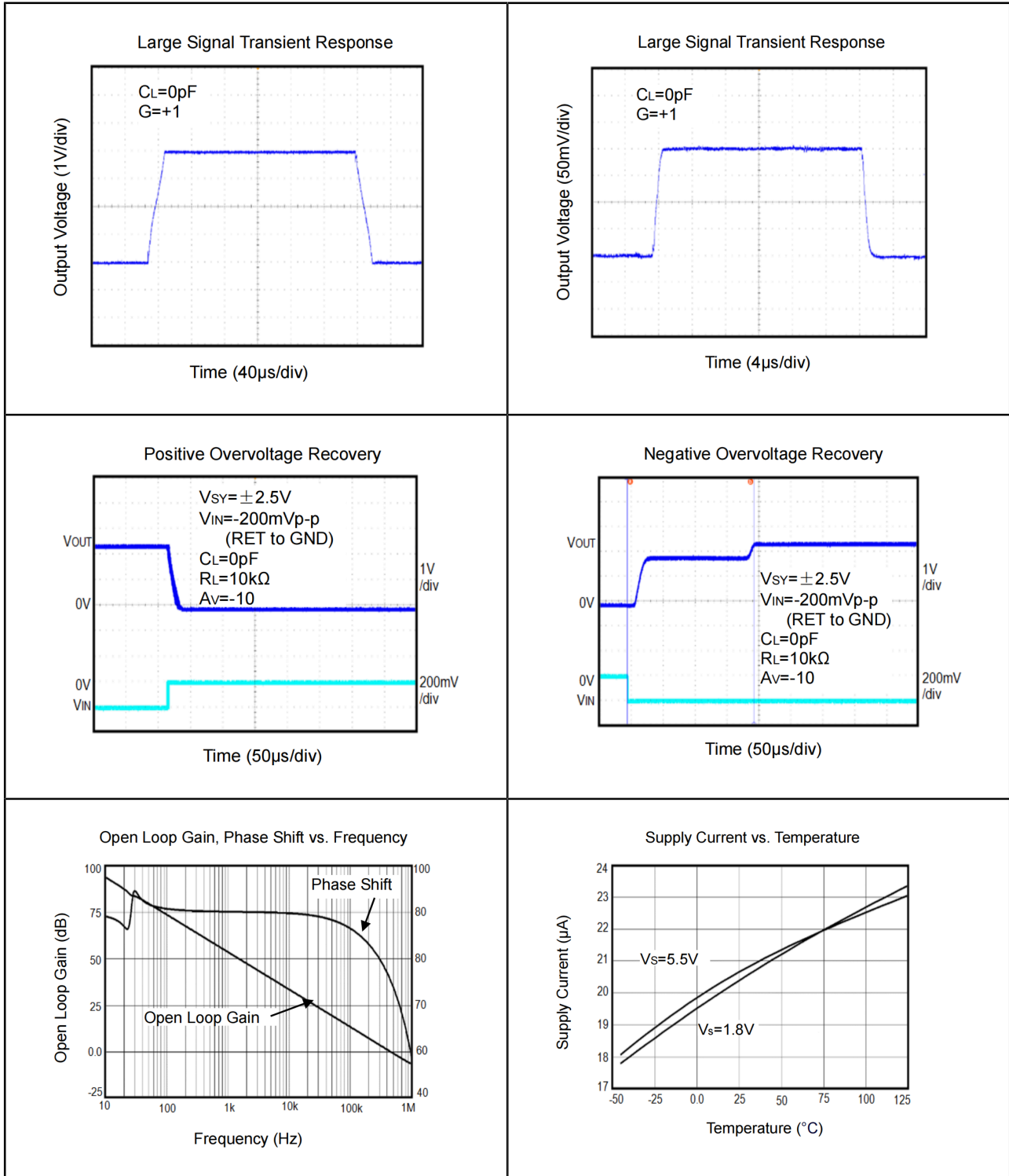
At $V_S = +5\text{V}$, $T_A = 25^\circ\text{C}$, $V_{CM} = V_S/2$, $R_L = 10\text{k}\Omega$, unless otherwise noted.

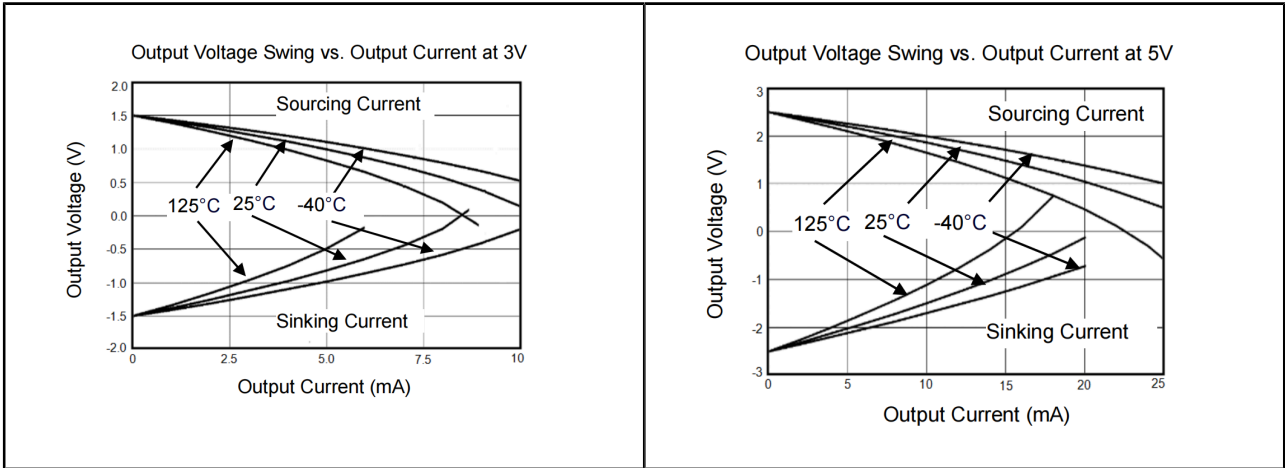
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Input Offset Voltage	V_{OS}	$T_A = 25^\circ\text{C}$		2	10	μV
		$-45^\circ\text{C} < T_A < 125^\circ\text{C}$			15	
Input Bias Current	I_B	$T_A = 25^\circ\text{C}$		20	200	pA
		$-45^\circ\text{C} < T_A < 125^\circ\text{C}$			2000	
Input Offset Current	I_{OS}	$T_A = 25^\circ\text{C}$		10	200	pA
		$-45^\circ\text{C} < T_A < 125^\circ\text{C}$			2000	
Common-Mode Rejection Ratio	CMRR	$V_{CM} = 0\text{V to } 5\text{V}$, $T_A = 25^\circ\text{C}$	100	110		dB
		$V_{CM} = 0\text{V to } 5\text{V}$, $-45^\circ\text{C} < T_A < 125^\circ\text{C}$	90			
Large Signal Voltage Gain	A_{VO}	$V_O = 0.3\text{V to } 4.7\text{V}$, $T_A = 25^\circ\text{C}$	120	145		dB
		$V_O = 0.3\text{V to } 4.7\text{V}$, $-45^\circ\text{C} < T_A < 125^\circ\text{C}$	110			
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-45^\circ\text{C} < T_A < 125^\circ\text{C}$		10	50	$\text{nV}/^\circ\text{C}$
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	$R_L = 100\text{k}\Omega$ to $-V_S$		4.998		V
		$R_L = 10\text{k}\Omega$ to $-V_S$		4.994		
Output Voltage Low	V_{OL}	$R_L = 100\text{k}\Omega$ to $+V_S$		5		mV
		$R_L = 10\text{k}\Omega$ to $+V_S$		20		

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Short Circuit Limit (I_{SC})	I_{SOURCE}	$R_L = 10\Omega$ to $-V_S$, $T_A = 25^\circ\text{C}$	15	20		mA
		$R_L = 10\Omega$ to $-V_S$, $-45^\circ\text{C} < T_A < 125^\circ\text{C}$	14			
	I_{SINK}	$R_L = 10\Omega$ to $-V_S$, $T_A = 25^\circ\text{C}$	15	20		mA
		$R_L = 10\Omega$ to $-V_S$, $-45^\circ\text{C} < T_A < 125^\circ\text{C}$	14			
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	$V_S = 2.5\text{V}$ to 5.5V , $T_A = 25^\circ\text{C}$	110	115		dB
		$V_S = 2.5\text{V}$ to 5.5V , $-45^\circ\text{C} < T_A < 125^\circ\text{C}$	100			
Quiescent Current	I_Q	$V_O = 0\text{V}$, $T_A = 25^\circ\text{C}$		25	40	μA
		$V_O = 0\text{V}$, $-45^\circ\text{C} < T_A < 125^\circ\text{C}$			50	
DYNAMIC PERFORMANCE						
Gain-Bandwidth Product	GBP	$G = +100$		350		kHz
Slew Rate	SR	$R_L = 10\text{k}\Omega$		0.2		$\text{V}/\mu\text{s}$
NOISE PERFORMANCE						
Voltage Noise	$e_{n\text{ p-p}}$	0Hz to 10Hz		1.1		$\mu\text{V}_{\text{P-P}}$
Voltage Noise Density	e_n	$f = 1\text{kHz}$		70		$\text{nV}/\sqrt{\text{Hz}}$

2 Typical Performance Characteristics

$T_A = +25^\circ\text{C}$, $V_S = 5\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$ and $V_{OUT} = V_S/2$, unless otherwise noted.





3 Application Note

3.1 Size

SNA8331Q op amp is unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the SNA8331Q packages save space on printed circuit boards and enable the design of smaller electronic products.

3.2 Power Supply Bypassing and Board Layout

SNA8331Q operates from a single 1.8V to 5.5V supply or dual $\pm 0.9V$ to $\pm 2.75V$ supplies. For best performance, a 0.1 μF ceramic capacitor should be placed close to the VDD pin in single supply operation. For dual supply operation, both V_{DD} and V_{SS} supplies should be bypassed to ground with separate 0.1 μF ceramic capacitors.

3.3 Low Supply Current

The low supply current (typical 25 μA) of SNA8331Q will help to maximize battery life. They are ideal for battery powered systems.

3.4 Operating Voltage

SNA8331Q operates under wide input supply voltage (1.8V to 5.5V). In addition, all temperature specifications apply from $-45^{\circ}C$ to $+125^{\circ}C$. Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime.

3.5 Rail-to-Rail Input

The input common-mode range of SNA8331Q extends 100mV beyond the supply rails ($V_{SS}-0.1V$ to $V_{DD}+0.1V$). This is achieved by using complementary input stage. For normal operation, inputs should be limited to this range.

3.6 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 SNA8331Q can typically swing to less than 5mV from supply rail in light resistive loads ($>100k\Omega$), and 100mV of supply rail in moderate resistive loads (10k Ω).

3.7 Capacitive Load Tolerance

The SNA8331Q 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 4-1 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.

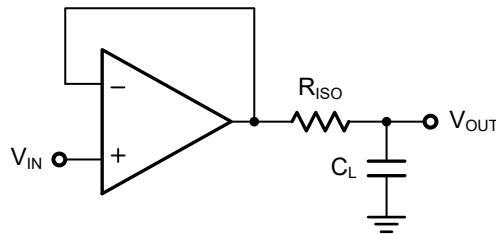


Figure 3-1 Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. However, if there is a resistive load R_L 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 4-2 is an improvement to the one in Figure 4-1. 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.

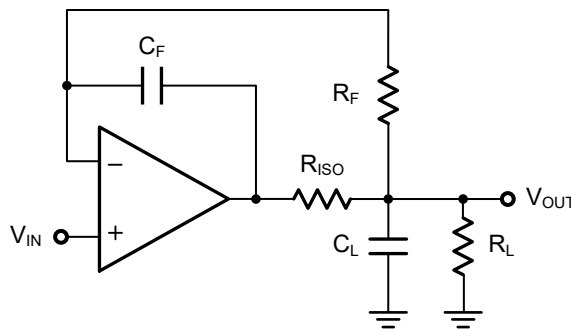


Figure 3-2 Indirectly Driving a Capacitive Load with DC Accuracy

4 Typical Application Circuits

4.1 Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common to 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 5-1 shows the differential amplifier using SNA8331Q.

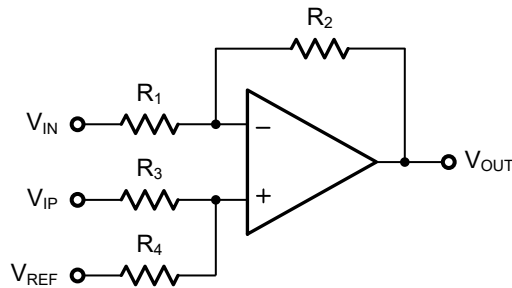


Figure 4-1 Differential Amplifier

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

If the resistor ratios are equal (i.e. $R_1=R_3$ and $R_2=R_4$), then

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

4.2 Low Pass Active Filter

The low pass active filter is shown in Figure 5-2. The DC gain is defined by $-R_2/R_1$. The filter has a -20dB/decade roll-off after its corner frequency $f_c = 1/(2\pi R_3 C_1)$.

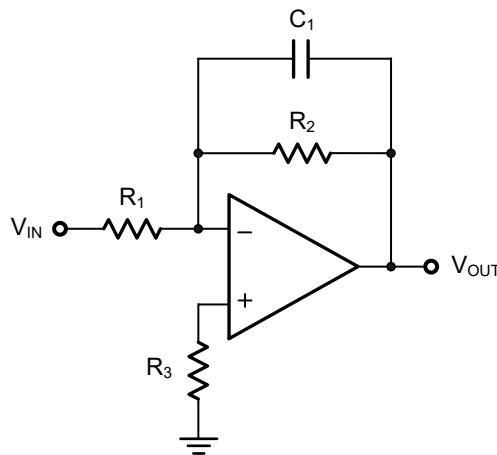


Figure 4-2 Low Pass Active Filter

4.3 Instrumentation Amplifier

The triple SNA8331Q can be used to build a three-op-amp instrumentation amplifier as shown in Figure 5-3. The amplifier in Figure 5-3 is a high input impedance differential amplifier with gain of R_2/R_1 . The two differential voltage followers assure the high input impedance of the amplifier.

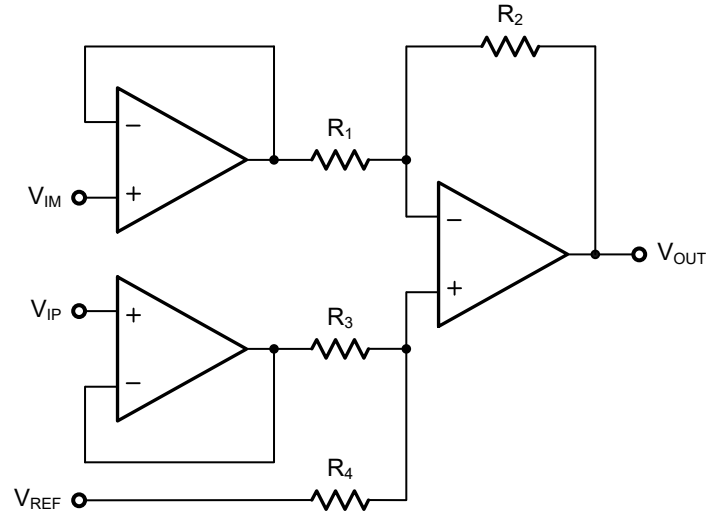
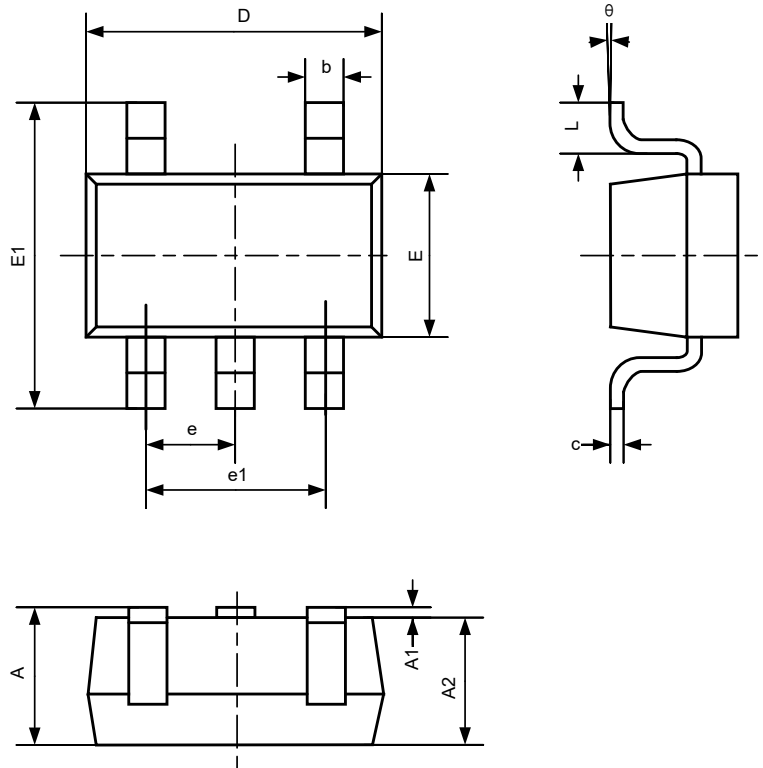


Figure 4-3 Instrument Amplifier

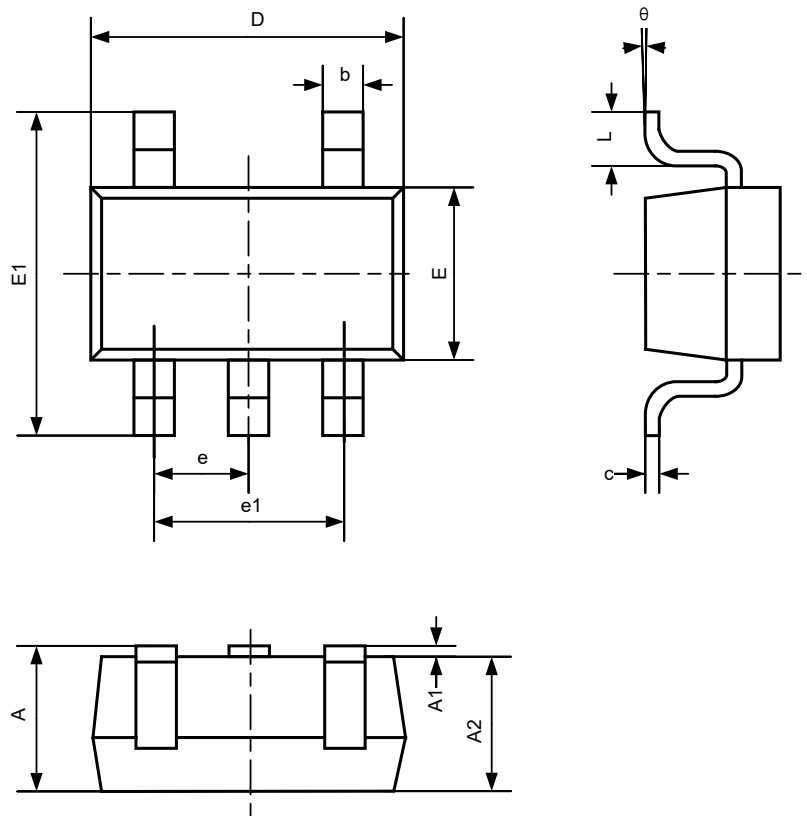
5 Package Information

5.1 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	0.650 BSC		0.026 BSC	
e1	1.300 BSC		0.051 BSC	
L	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

5.2 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°

6 Revision History

Version	Date	Description
0.1	2021/12/05	Initial release
0.2	2022/11/08	Update some specification informations

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