DESCRIPTION

The AO1313 is single channel op amps represents a new generation of low cost, general purpose, micro-power operational amplifiers. Feature rail-to-rail input and output swings and low quiescent current (75uA, typ. at 5V) combined with a wide gain-bandwidth product of 1MHz and very low noise (27nV/ $\sqrt{Hz}$ at 1kHz) , a slew rate of 0.8V/µs makes AO1313 very attractive for a variety of battery-power applications that require an optimal performance in low voltage and low noise systems.

AO1313 provides rail-to-rail output swing into heavy loads, RF/EMI rejection filter and high electrostatic discharge (ESD) protection (6-kV HBM). The AO1313 input common mode voltage range includes ground, and the maximum input offset voltage is 3.5mV.

The AO1313 are optimized for operation at voltages as low as +1.8V and up to +6V and are specified over the extended industrial temperature range (-40℃ to +125℃).

The AO1313 is available in SOT-25 and SC70-5 packages.

ORDERING INFORMATION

Package Type	Part Number	
SOT-25 SPQ: 3,000pcs/Reel	E5	AO1313E5R-Z
		AO1313E5VR-Z
SC70-5 SPQ: 3,000pcs/Reel	C5	AO1313C5R-Z
		AO1313C5VR-Z
Note	Z: Pin Type(See Pin Description) V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products		

FEATURES

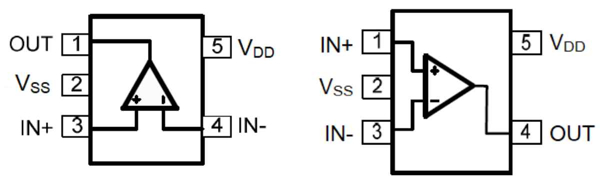
- Low Quiescent Current: 75µA/ch (Typ.)
- Wide Supply Range: 1.8V to +6V
- Low Noise: 27nV/ $\sqrt{Hz}$ at 1kHz
- Gain-Bandwidth Product: 1MHz (Typ.)
- Low Input Bias Current: 1pA (Typ.)
- Low Offset Voltage: 3.5mV (Max.)
- Internal RF / Anti-EMI Filter
- Rail-to-Rail Input / Output
- Operating Temperature: -40°C ~ +125°C
- Available in SOT-25 and SC70-5 packages

APPLICATION

- Battery-Power Instruments:
  -Consumer, Industrial, Medical
  -Notebooks, Portable Media Players
- Sensor Signal Conditioning:
  -Loop-Powered
  -Notebooks, Portable Media Players
- Wireless Sensors:
  -Home Security
  -Remote Sensing
  -Wireless Metering
- Others:
  -ASIC Input or Output Amplifier
  -Sensor Interface
  -Smoke Detectors
  -Audio Output
  -Piezoelectric Transducer Amplifier

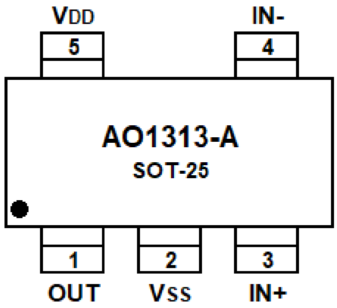
TYPICAL APPLICATION

AO1313-A AO1313-B

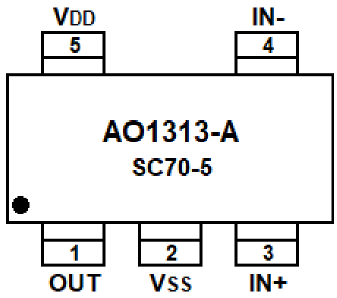


SOT-25/ SC70-5

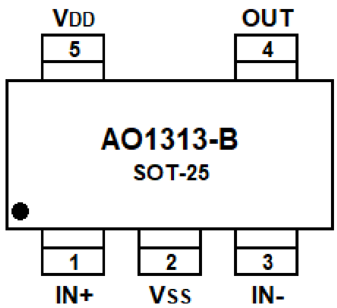
PIN DESCRIPTION



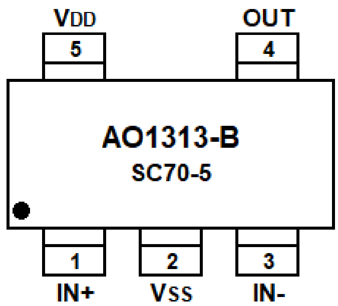
Type A - Top View



Type A -Top View



Type B - Top View



Type B - Top View

Pin #				Symbol	Function
SOT-25		SC70-5			
Type		Type			
A	B	A	B		
1	4	1	4	OUT	Output
2	2	2	2	V_{SS}	Ground or Negative Power Supply Input
3	1	3	1	IN+	Analog Positive Input
4	3	4	3	IN-	Analog Inverting Input
5	5	5	5	V_{DD}	Positive Power Supply Input

ABSOLUTE MAXIMUM RATINGS

Power Supply Voltage (V_{DD} to V_{SS})	-0.5V ~ +7.5V
Analog Input Voltage (IN+ or IN-)	Vss-0.5V ~ V_{DD}+0.5V
PDB Input Voltage	Vss-0.5V ~ +7V
Operating Temperature Range	-40°C ~ 125°C
Junction Temperature	+160°C
Storage Temperature Range	-55°C ~ 150°C
Lead Temperature (soldering, 10sec)	+260°C
Package Thermal Resistance (T_A=+25℃)	
θ_{JA}, SOT-25	190°C/W
θ_{JA}, SC70-5	333°C/W
ESD Susceptibility	
HBM	6kV
MM	400V

Stress beyond above listed “Absolute Maximum Ratings” may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

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

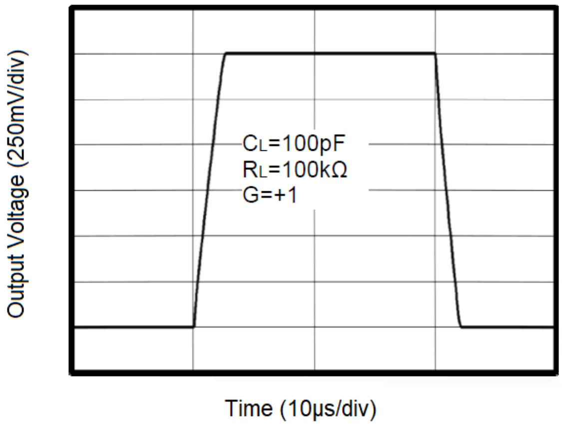
Parameter	Symbol	Conditions	Typ	Min/Max Over Temperature			
			+25℃	+25℃	-40℃ to 85℃	Unit	Min / Max
INPUT CHARACTERISTICS							
Input Offset Voltage	V_{OS}	V_{CM} = V_S/2	0.8	3.5	5.6	mV	Max
Input Bias Current	I_B		1	-	-	pA	Typ
Input Offset Current	I_{OS}		1	-	-	pA	Typ
Input Common Mode Voltage Range	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	62	dB	Min
		V_S = 5.5V, V_{CM} = -0.1V to 5.6V	68	56	55	dB	Min
Open-Loop Voltage Gain	A_{OL}	R_L = 5kΩ, V_O = +0.1V to +4.9V	80	70	70	dB	Min
		R_L = 10kΩ, V_O = +0.1V to +4.9V	100	94	85	dB	Min
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta_T$		2.7	-	-	μV/°C	Typ
OUTPUT CHARACTERISTICS							
Output Voltage Swing from Rail	V_{OH}	R_L = 100kΩ	4.997	4.980	4.970	V	Min
	V_{OL}	R_L = 100kΩ	5	20	30	mV	Max
	V_{OH}	R_L = 10kΩ	4.992	4.970	4.960	V	Min
	V_{OL}	R_L = 10kΩ	8	30	40	mV	Max
Output Current	I_{SOURCE}	R_L = 10Ω to V_S/2	84	60	45	mA	Min
	I_{SINK}		75	60	45		
POWER SUPPLY							
Operating Voltage Range			-	1.8	1.8	V	Min
			-	6	6	V	Max
Power Supply Rejection Ratio	PSRR	V_S = +2.5V to +6V, V_{CM} = +0.5V	82	60	58	dB	Min
Quiescent Current/Amplifier	I_Q		75	110	125	μA	Max

Parameter	Symbol	Conditions	Typ	Min/Max Over Temperature			
			+25°C	+25°C	-40°C to 85°C	Unit	Min / Max
DYNAMIC PERFORMANCE (C_L = 100pF)							
Gain-Bandwidth Product	GBP		1	-	-	MHz	Typ
Slew Rate	SR	G = +1, 2V Output Step	0.8	-	-	V/μs	Typ
Settling Time to 0.1%	t_S	G = +1, 2V Output Step	5.3	-	-	μs	Typ
Overload Recovery Time		V_{IN} ·Gain = V_S	2.6	-	-	μs	Typ
NOISE PERFORMANCE							
Voltage Noise Density	e_n	f = 1kHz	27	-	-	$nV/\sqrt{Hz}$	Typ
		f = 10kHz	20	-	-	$nV/\sqrt{Hz}$	Typ

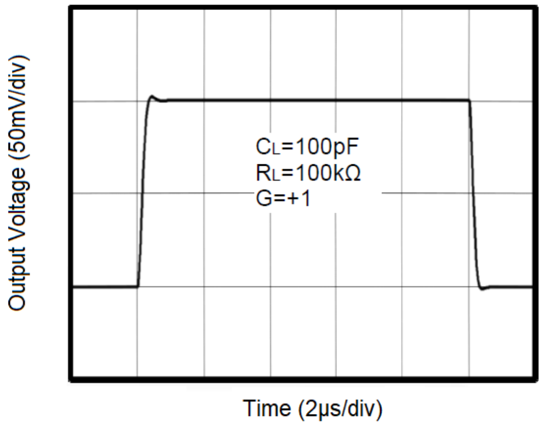
TYPICAL PERFORMANCE CHARACTERISTICS

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

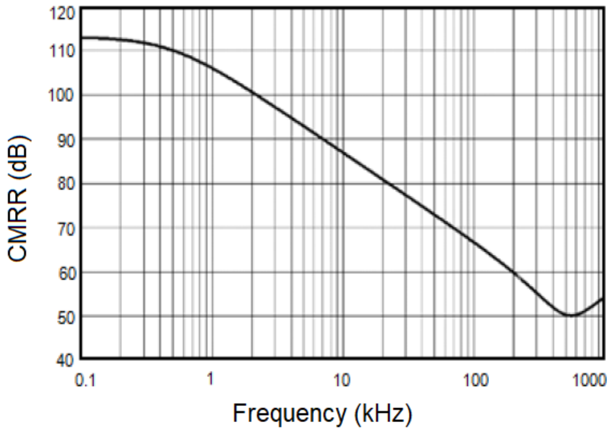
1. Large Signal Transient Response



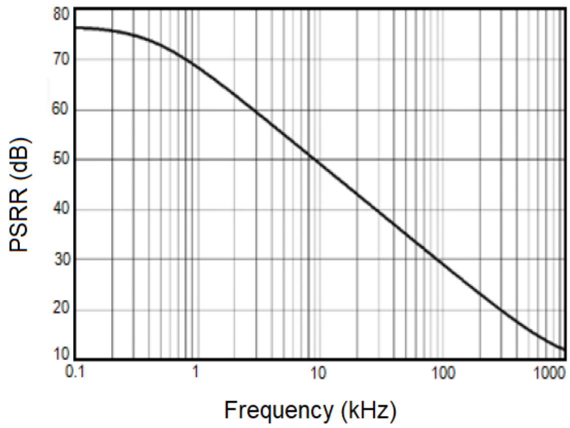
2. Small Signal Transient Response



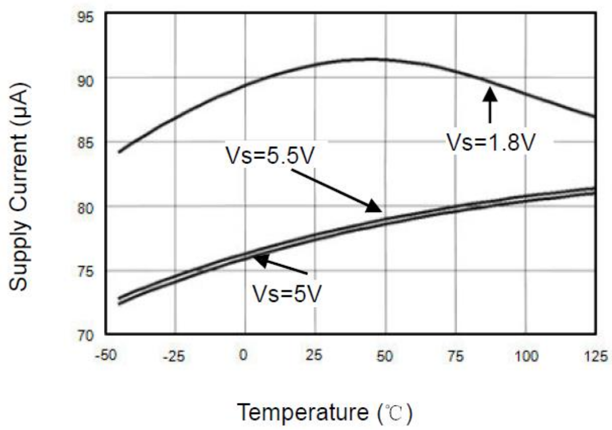
3. CMRR vs. Frequency



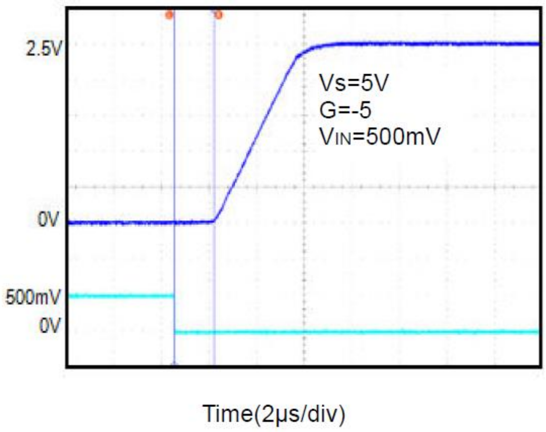
4. PSRR vs. Frequency



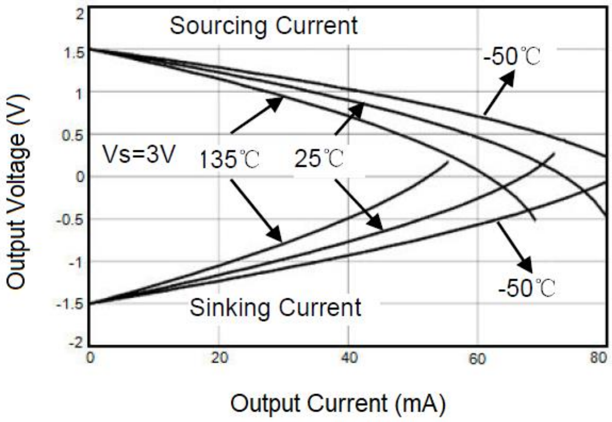
5. Supply Current vs. Temperature



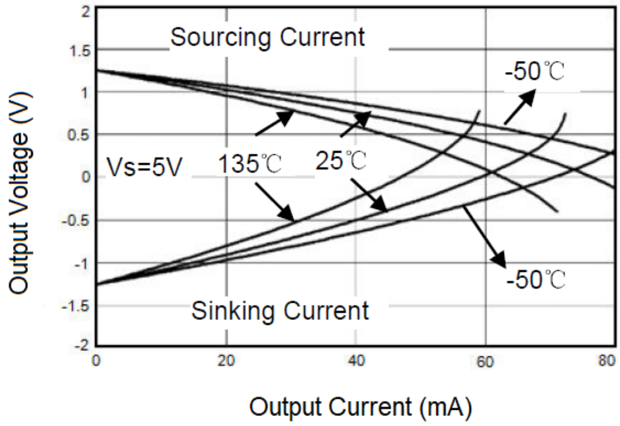
6. Overload Recovery Time



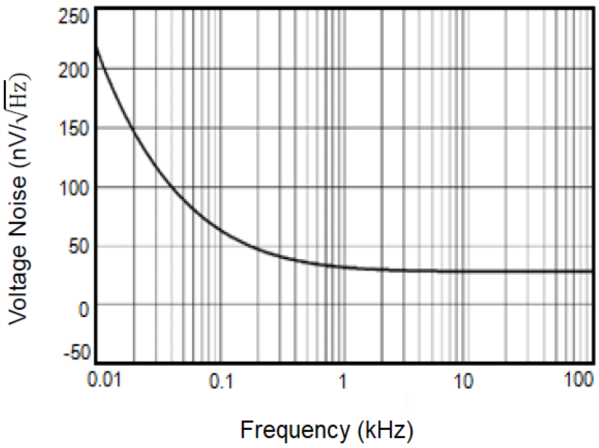
7. Output Voltage Swing vs. Output Current



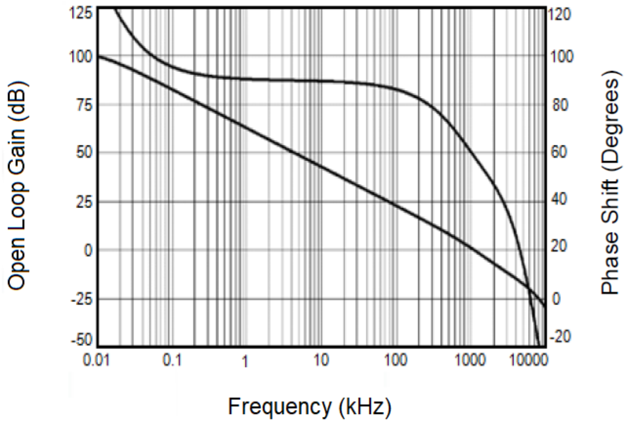
8. Output Voltage Swing vs. Output Current



9. Input Voltage Noise Spectral Density vs. Frequency



10. Open Loop Gain, Phase Shift vs. Frequency



DETAILED INFORMATION

Size

AO1313 op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the AO1313 packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

AO1313 operates from a single 1.8V to 6V supply or dual ±0.9V to ±3V supplies. For best performance, a 0.1μF ceramic capacitor should be placed close to the V_{DD} pin in single supply operation. For dual supply operation, both V_{DD} and V_{SS} supplies should be bypassed to ground with separate 0.1μF ceramic capacitors.

Low Supply Current

The low supply current (typical 75μA per channel) of AO1313 will help to maximize battery life. They are ideal for battery powered systems.

Operating Voltage

AO1313 operates under wide input supply voltage (1.8V to 6V). In addition, all temperature specifications apply from -40℃ to +125℃. Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime

Rail-to-Rail Input

The input common-mode range of AO1313 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.

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 AO1313 can typically swing to less than 10mV from supply rail in light resistive loads (>100kΩ), and 60mV of supply rail in moderate resistive loads (10kΩ).

Capacitive Load Tolerance

The AO1313 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. shown 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.

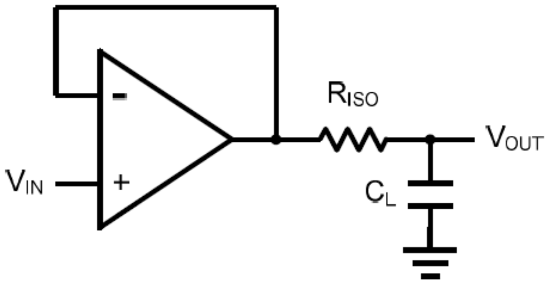


Figure 1. Indirectly Driving a Capacitive Load Using Isolation Resistor

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 2. is an improvement to the one in Figure 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.

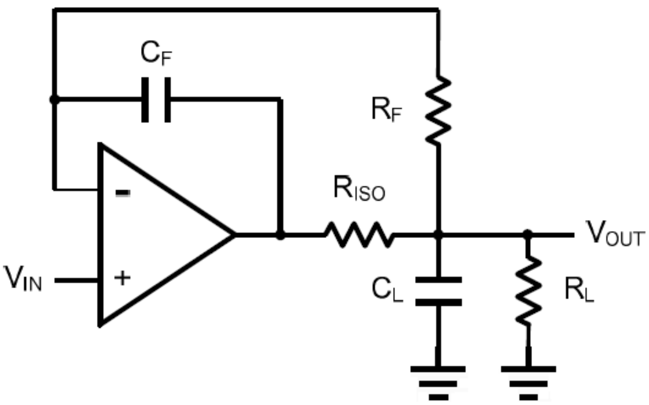


Figure 2. Indirectly Driving a Capacitive Load with DC Accuracy

Typical Application Circuits

Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common 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 3. shown the differential amplifier using AO1313.

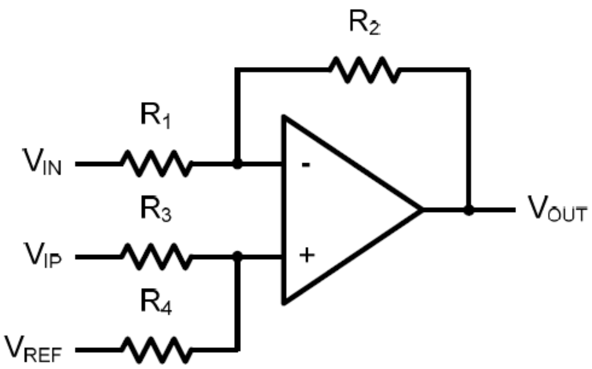


Figure 3. Differential Amplifier

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

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

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

Low Pass Active Filter

The low pass active filter is shown in Figure 4. The DC gain is defined by $-R_2/R_1$. The filter has a -20dB/decade roll-off after its corner frequency $f_C=1/(2\pi R_3C_1)$.

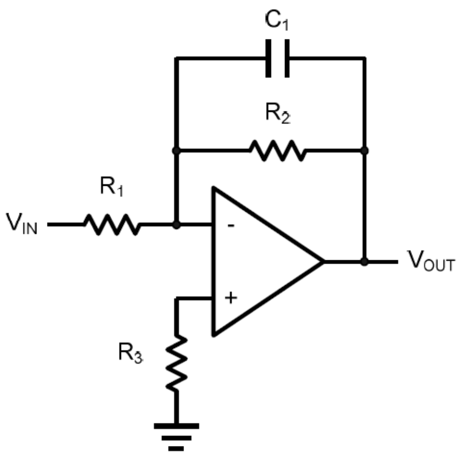


Figure 4. Low Pass Active Filter

Instrumentation Amplifier

The triple AO1313 can be used to build a three-op-amp instrumentation amplifier as shown in Figure 5. The amplifier in Figure 5. 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.

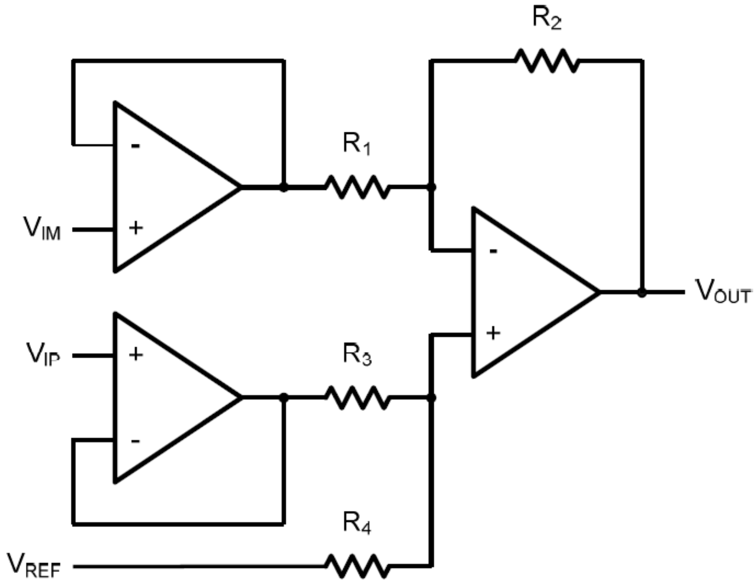
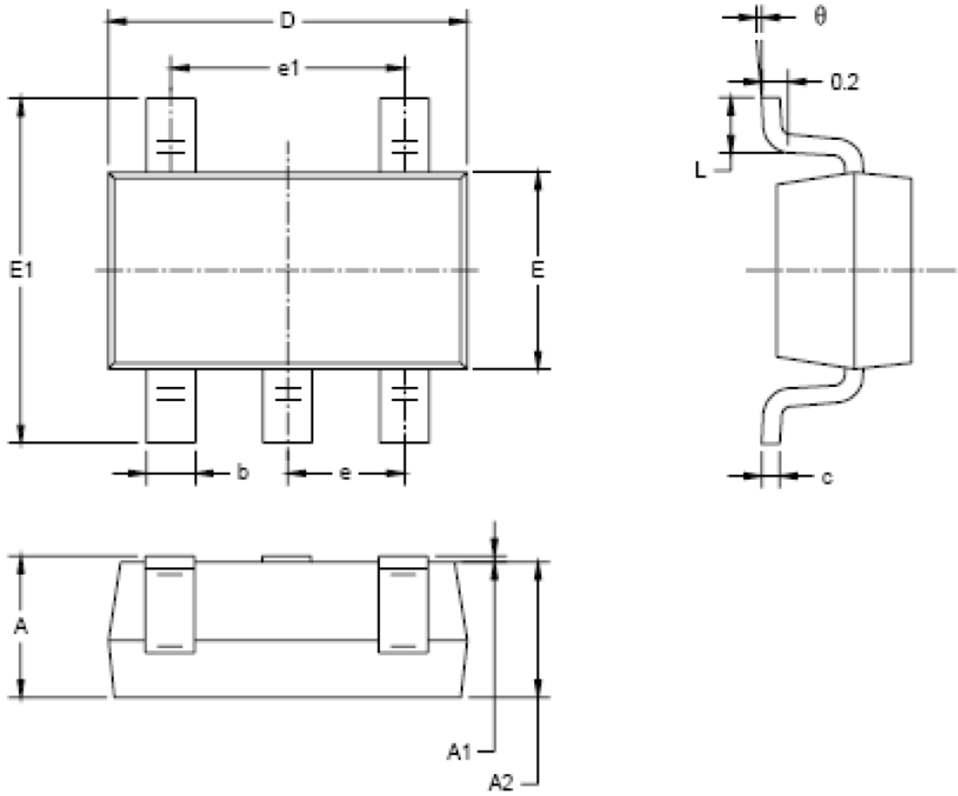


Figure 5. Instrument Amplifier

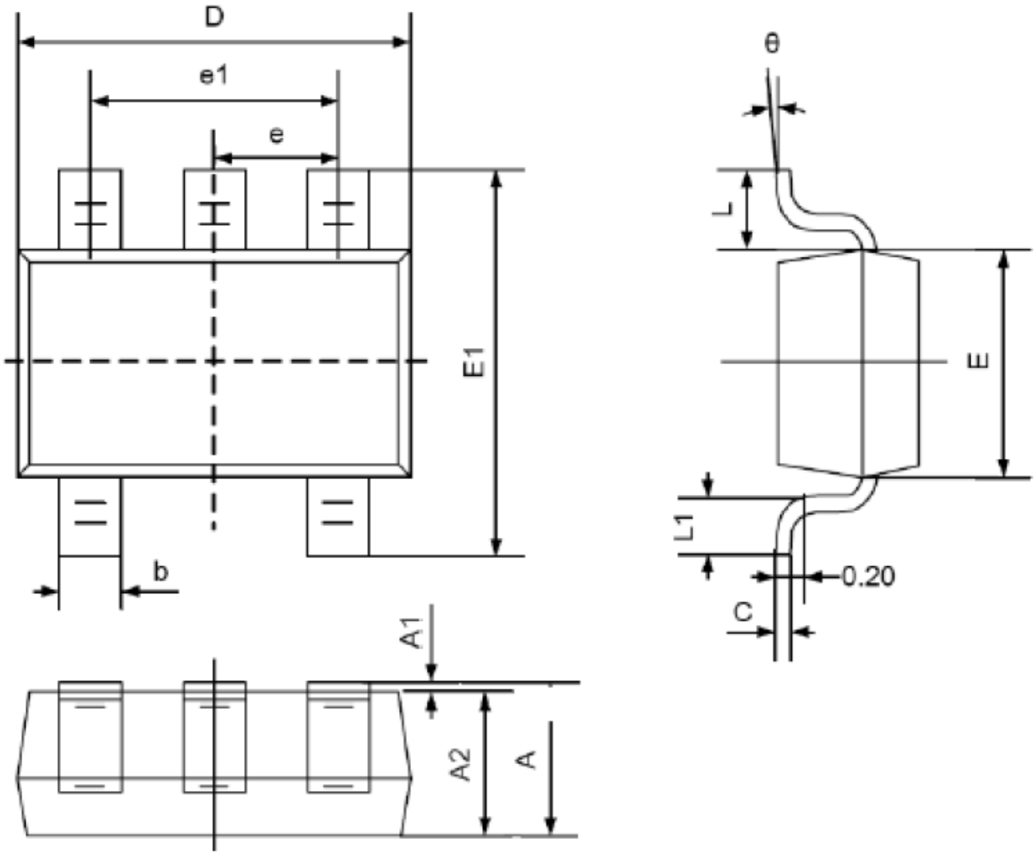
PACKAGE INFORMATION

Dimension in SOT-25 (Unit: mm)



Symbol	Millimeters		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°

Dimension in SC70-5 (Unit: mm)



Symbol	Millimeters		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 TYP		0.026 TYP	
e1	1.200	1.400	0.047	0.055
L	0.525 REF		0.021 REF	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

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