AO1317

OP AMPLIFIER

350kHz, ZERO-DRIFT, LOW NOISE, SINGLE RRIO, CMOS OPAMP WITH RF FILTER

DESCRIPTION

The AO1317 is single micro-power, low-voltage, zero-drift CMOS operational amplifiers. Feature rail-to-rail input and output swings and low quiescent current (25uA, typ. at 5V) combined with a wide gain-bandwidth product of 350kHz and very low noise (70nV/ $\sqrt{Hz}$ at 1kHz) makes AO1317 very attractive for a variety of battery-power applications.

The AO1317 amplifiers offer impressive bandwidth (350kHz), zero-drift over temperature, low bias current (20pA), very low offset voltage (10μV max) makes AO1317 to be a perfect choice for low offset, low power consumption and high impedance applications.

The AO1317 provides RF/EMI rejection filter, high electrostatic discharge (ESD) protection (6-kV HBM) and excellent CMRR without the crossover associated with traditional complementary input stages further to superior performance for driving analog-to-digital converters (ADCs) without degradation of differential linearity.

The AO1317 is optimized for operation at voltages as low as +1.8V and up to +5.5V and are specified over the extended industrial temperature range (-40℃ to +125℃).

The AO1317 is available in SOT-25 and SC70-5 packages.

ORDERING INFORMATION

Package Type	Part Number	
SOT-25 SPQ: 3,000pcs/Reel	E5	AO1317E5R
		AO1317E5VR
SC70-5 SPQ: 3,000pcs/Reel	C5	AO1317C5R
		AO1317C5VR
Note	V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products		

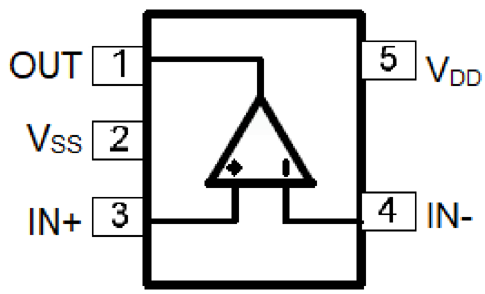
FEATURES

- Low Noise: 1.1μVpp (0Hz-10Hz)
- CMRR: 100dB (V_{CM} = 0V to 5V @25℃)
- Low Quiescent Current: 25μA/ch (Typ.)
- Wide Supply Range: 1.8V to 5.5V
- Zero Drift: 0.05μV/°C (Typ.)
- Wide Gain-Bandwidth: 350kHz (Typ. @25°C)
- Low Input Bias Current: 20pA (Typ. @25°C)
- Low Offset Voltage: 10uV (Max. @25°C)
- Internal RF Anti-EMI Filter
- Operating Temperature: -45°C ~ +125°C
- Rail-to-Rail Input / Output
- Available in SOT-25 and SC70-5 packages

APPLICATION

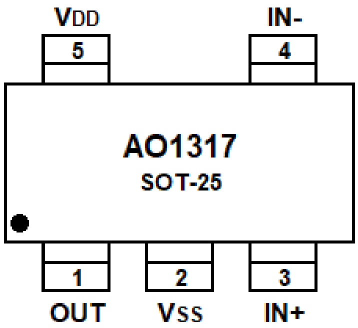
- Battery-Powered Instrumentation
- Portable Devices
- Medical Instruments
- Handheld Test Equipment
- Transducer Application
- Temperature Measurements
- Electronics Scales

TYPICAL APPLICATION

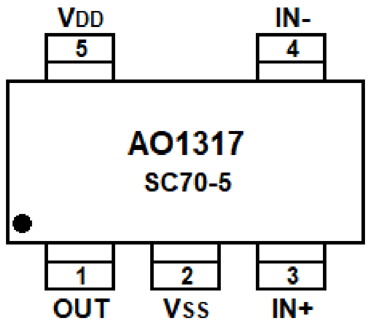


SOT-25/ SC70-5

PIN DESCRIPTION



Top View



Top View

Pin #		Symbol	Function
SOT-25	SC70-5		
1	1	OUT	Output
2	2	V_{SS}	Ground or Negative Power Supply Input
3	3	IN+	Analog Positive Input
4	4	IN-	Analog Inverting Input
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	-45°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°C)	
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

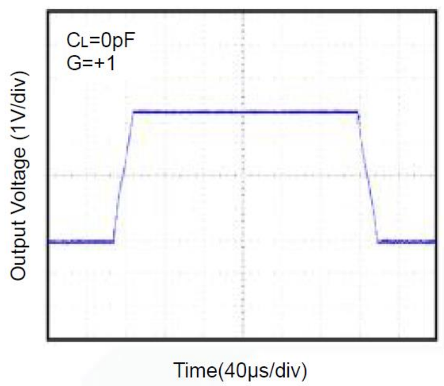
At V_S=5V, T_A = +25℃, V_{CM} = V_S/2, R_L = 10KΩ, unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Input Offset Voltage	V_{OS}	T=25℃	-	2	10	μV
		-45℃<T<125℃	-	-	15	
Input Bias Current	I_B	T=25℃	-	20	200	pA
		-45℃<T<125℃	-	-	2000	
Input Offset Current	I_{OS}	T=25℃	-	10	200	pA
		-45℃<T<125℃	-	-	2000	
Common-Mode Rejection Ratio	CMRR	V_{CM} = 0V to 5V, T=25℃	100	110	-	dB
		V_{CM} = 0V to 5V, -45℃<T<125℃	90	-	-	
Large Signal Voltage Gain	A_{VO}	V_O = 0.3V to 4.7V, T=25℃	120	145	-	dB
		V_O = 0.3V to 4.7V, -45℃<T<125℃	110	-	-	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta_T$	-45℃<T<125℃	-	50	70	nV/°C
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 100kΩ to – V_S	-	4.998	-	V
		R_L = 10kΩ to - V_S	-	4.994	-	
Output Voltage Low	V_{OL}	R_L = 100kΩ to + V_S	-	5	-	mV
		R_L = 10kΩ to + V_S	-	20	-	
Short Circuit Limit, I_{SOURCE}	I_{SC}	R_L =10Ω to - V_S, T=25℃	15	20	-	mA
		R_L =10Ω to - V_S, -45℃<T<125℃	14	-	-	
Short Circuit Limit, Isink	I_{SC}	R_L =10Ω to - V_S, T=25℃	15	20	-	mA
		R_L =10Ω to - V_S, -45℃<T<125℃	14	-	-	
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = 2.5V to 5.5V, T=25℃	110	115	-	dB
		V_S = 2.5V to 5.5V, -45℃<T<125℃	100	-	-	
Quiescent Current	I_Q	V_O = 0V, T=25℃	-	25	40	μA
		V_O = 0V, -45℃<T<125℃	-	-	50	
DYNAMIC PERFORMANCE						
Gain-Bandwidth Product	GBP	G = +100	-	350	-	kHz
Slew Rate	SR	R_L = 10kΩ	-	0.2	-	V/μs
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	0Hz to 10Hz	-	1.1	-	μV_{P-P}
Voltage Noise Density	e_n	f = 1kHz	-	70	-	$nV/\sqrt{Hz}$

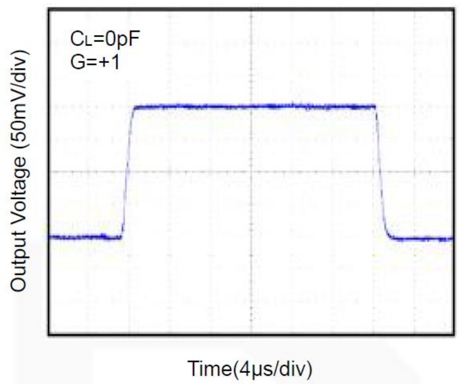
TYPICAL PERFORMANCE CHARACTERISTICS

T_A=+25°C, V_S=5V, R_L=10kΩ connected to V_S/2 and V_{OUT}= V_S/2, unless otherwise noted.

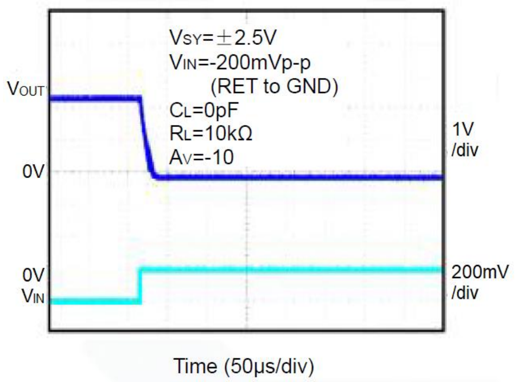
1. Large Signal Transient Response



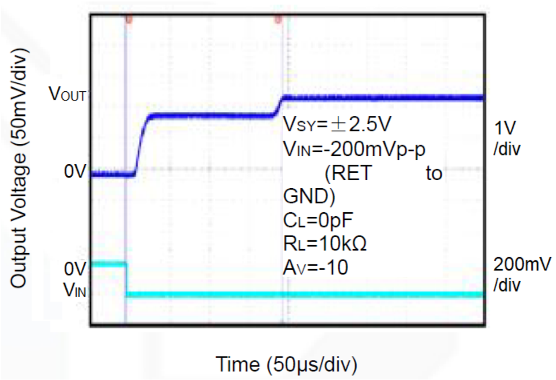
2. Large Signal Transient Response



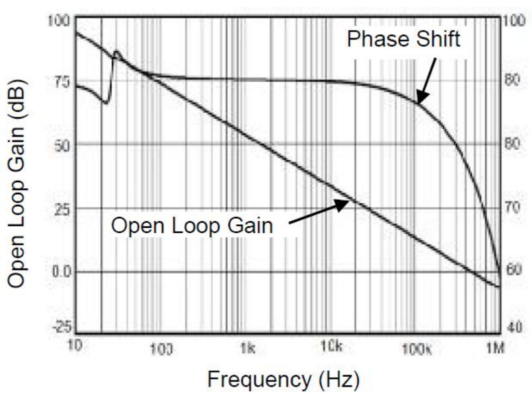
3. Positive Overvoltage Recovery



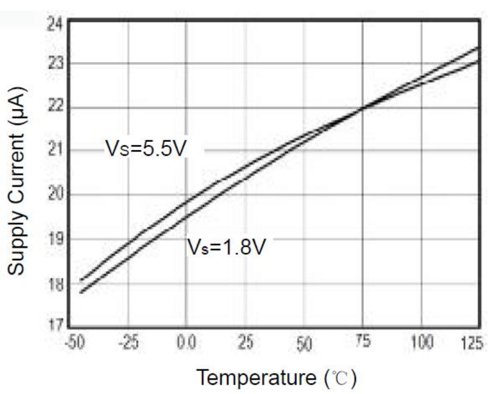
4. Negative Overvoltage Recovery



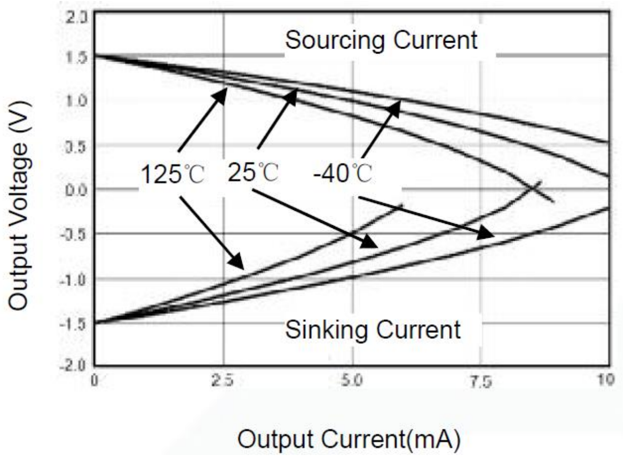
5. Open Loop Gain, Phase Shift vs. Frequency



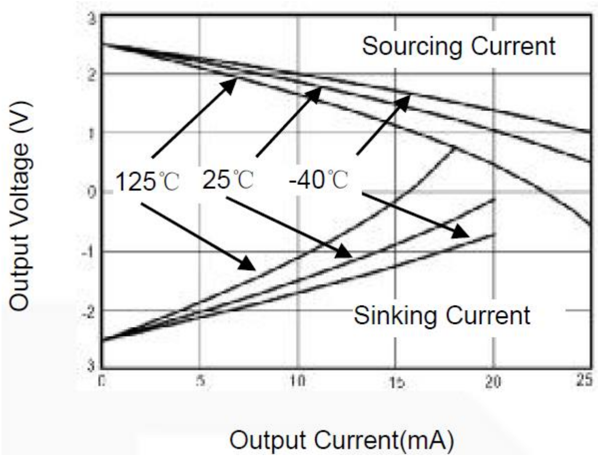
6. Supply Current vs. Temperature



7. Output Voltage Swing vs. Output Current at +3V



8. Output Voltage Swing vs. Output Current at +5V



DETAILED INFORMATION

Size

AO1317 series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the AO1317 series packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

AO1317 series operates from a single 1.8V to 5.5V supply or dual ±0.9V to ±2.75V 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 25uA per channel) of AO1317 series will help to maximize battery life. They are ideal for battery powered systems

Operating Voltage

AO1317 series operate under wide input supply voltage (1.8V to 5.5V). In addition, all temperature specifications apply from -45℃ 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 AO1317 series 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 AO1317 series can typically swing to less than 5mV from supply rail in light resistive loads (>100kΩ), and 100mV of supply rail in moderate resistive loads (10kΩ).

Capacitive Load Tolerance

The AO1317 family 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.

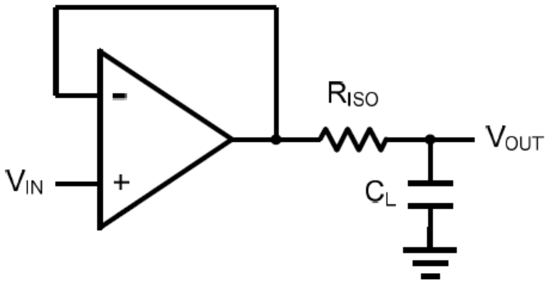


Figure 1. Indirectly Driving a Capacitive Load Using Isolation Resistor

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.

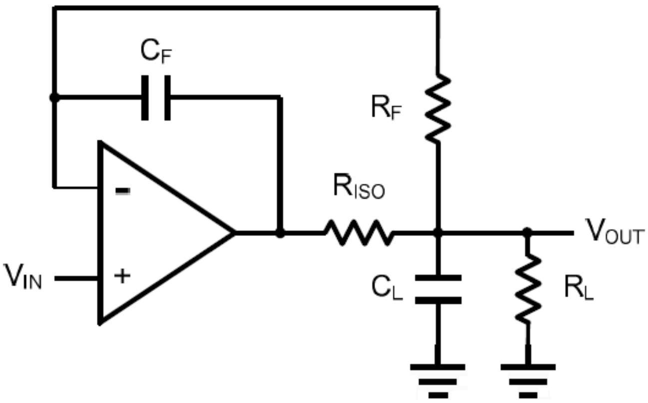


Figure 2. Indirectly Driving a Capacitive Load with DC Accuracy

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 AO1317.

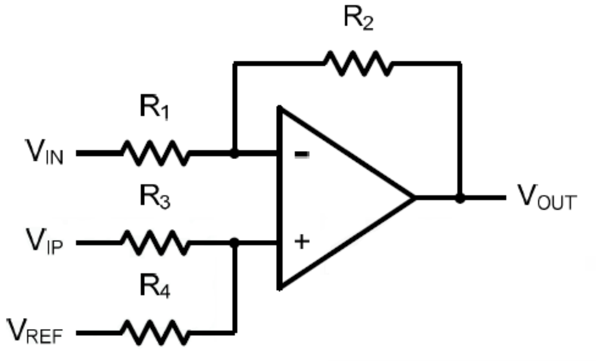


Figure 3. Differential Amplifier

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

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 $f_C=1/(2\pi R_3 C_1)$.

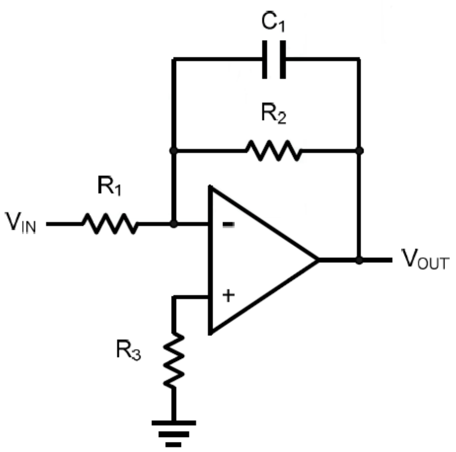


Figure 4. Low Pass Active Filter

Instrumentation Amplifier

The triple AO1317 can be used to build a three-op-amp instrumentation amplifier as shown in Figure5. The amplifier in Figure 5 is a high input impedance differential amplifier with gain of R2/R1. The two differential voltage followers assure the high input impedance of the amplifier.

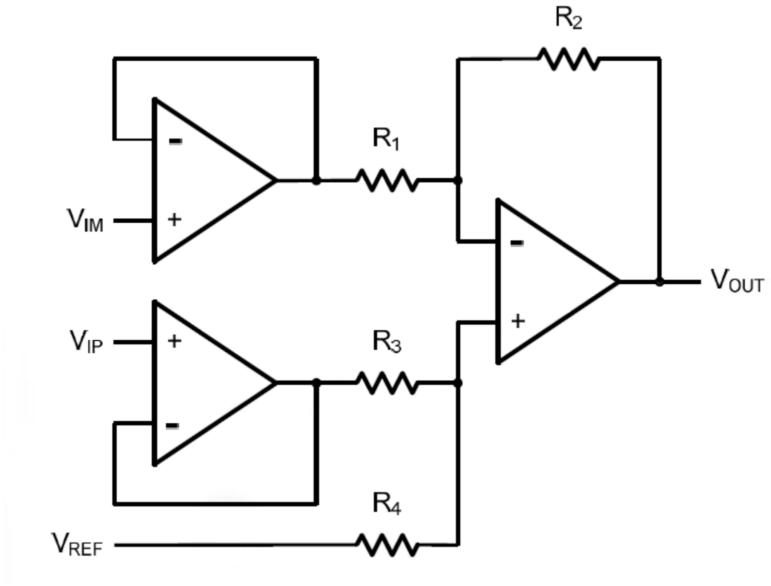
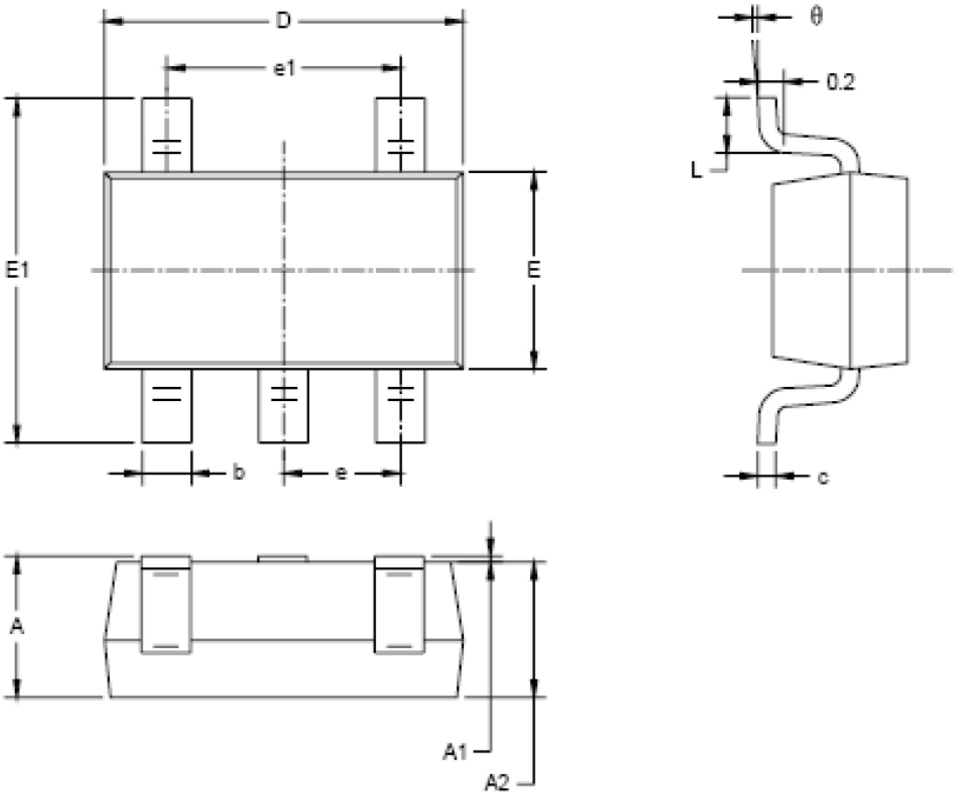


Figure 5. Instrument Amplifier

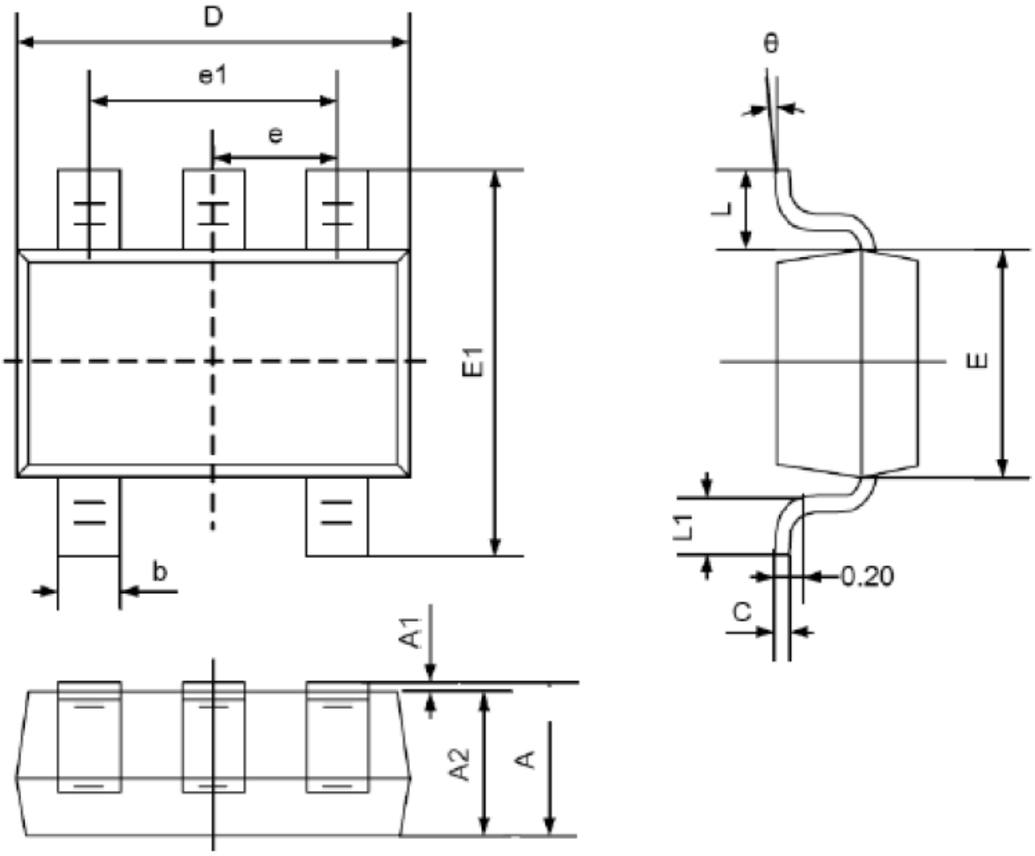
PACKAGE INFORMATION

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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