1.8MHZ Zero-Drift CMOS Rail-to-Rail IO Opamp with RF Filter

1 Features

- Single-Supply Operation from +1.8V ~ +5.5V
- Rail-to-Rail Input / Output
- Gain-Bandwidth Product: 1.8MHz (Typ@25°C)
- Low Input Bias Current: 20pA (Typ@25°C)
- Low Offset Voltage: 5uV (Max@25°C)
- Quiescent Current: 220μA per Amplifier (Typ)
- Operating Temperature: -45°C ~ +125°C
- Zero Drift: 0.005μV/°C (Typ)
- Embedded RF Anti-EMI Filter
- Small Package:
  - — MCOA335Z Available in SOT23-5 and SOP-8 Packages
  - — MCOA2335Z Available in MSOP-8 and SOP-8 Packages
  - — MCOA4335Z Available in SOP-14 and TSSOP-14 Packages

2 Applications

- Transducer Application
- Temperature Measurements
- Electronic Scales
- Battery-Powered Instruments
- Handheld Test Equipment

3 Description

The MCOAX335Z amplifier is single/dual/quad supply,micro-power, zero-drift CMOS operational amplifiers , the amplifiers offer bandwidth of 1. 8MHz, rail-to-rail inputs and outputs, and single-supply operation from 1 .8V to 5.5V.

MCOAX335Z uses chopper stabilized technique to provide very low offset voltage (less than 5μV maximum) and near zero drift over temperature. Low quiescent supply current of 220μA 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 MCOAX335Z 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 MCOA335Z is available in SOT23-5 and SOP -8 packages. And the MCOA2335Z is available in MSOP-8 and SOP-8 packages. The MCOA4335Z Quad is available in Green SOP-14 and TSSOP-14 packages. The extended temperature range of -45oC to +125oC overall supply voltages offers additional design flexibility .

4 Pin Configuration

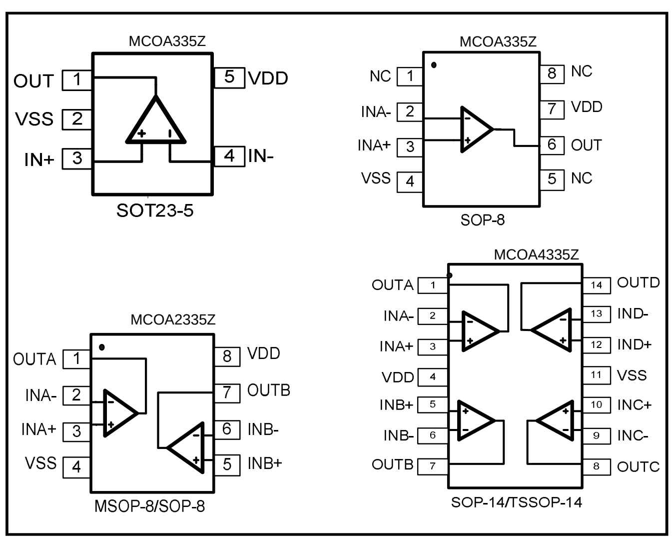


Figure 1. Pin Assignment Diagram

5 Specifications

5.1 Absolute Maximum Ratings

	MIN	TYP	MAX	UNIT
Power Supply voltage(V_{CC} to V_{SS})	-0.5		7.5	V
Analog Input Voltage(IN+ or IN-)	Vss-0.5		V_{DD}+0.5	V
PDB Input voltage	Vss-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

5.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	HBM	6000	V
		MM	400	

5.3 Package Thermal Resistance (TA=+25℃)

				UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	SOP-8	125	°C/W
		MSOP-8	216	
		SOT23-5	150	

NOTE: Stress greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions outside those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

5.4 Electrical Characteristics

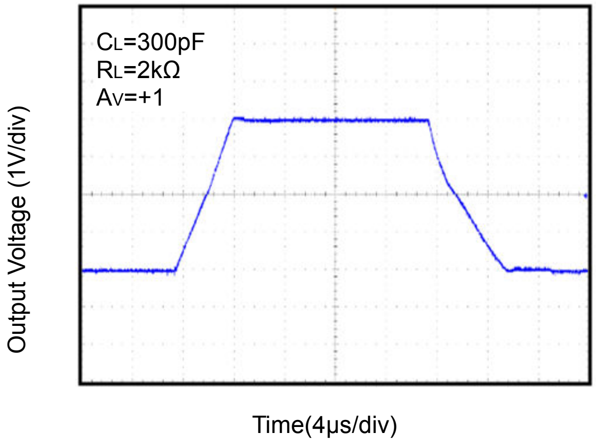
(At V_S=5V, T_A = +25°C, V_{CM} = V_S/2, R_L = 10KΩ, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS					
Input Offset Voltage (V_{OS})			1	5	μV
Input Bias Current (I_B)			20		pA
Input Offset Current (I_{OS})			10		pA
Common-Mode Rejection Ratio (CMRR)	V_{CM} = 0V to 5V		110		dB
Large Signal Voltage Gain (A_{VO})	R_L = 10kΩ, V_O = 0.3V to 4.7V		145		dB
Input Offset Voltage Drift ($\Delta V_{OS}/\Delta_T$)					
OUTPUT CHARACTERISTICS					
Output Voltage High (V_{OH})	R_L = 100kΩ to - V_S		4.998		V
	R_L = 10kΩ to - V_S		4.994		V
Output Voltage Low (V_{OL})	R_L = 100kΩ to + V_S		2		mV
	R_L = 10kΩ to + V_S		5		mV
Short Circuit Limit (I_{SC})	R_L =10Ω to - V_S		60		mA
Output Current (I_O)			65		mA
POWER SUPPLY					
Power Supply Rejection Ratio (PSRR)	V_S = 2.5V to 5.5V		115		dB
Quiescent Current (I_Q)	V_O = 0V, R_L = 0Ω		220		μA
DYNAMIC PERFORMANCE					
Gain-Bandwidth Product (GBP)	G = +100		1.8		MHz
Slew Rate (SR)	R_L = 10kΩ		0.95		V/μs
Overload Recovery Time			0.10		ms
NOISE PERFORMANCE					
Voltage Noise (e_n p-p)	0Hz to 10Hz		0.3		μV_{P-P}
Voltage Noise Density (e_n)	f = 1kHz		38		$nV/\sqrt{Hz}$

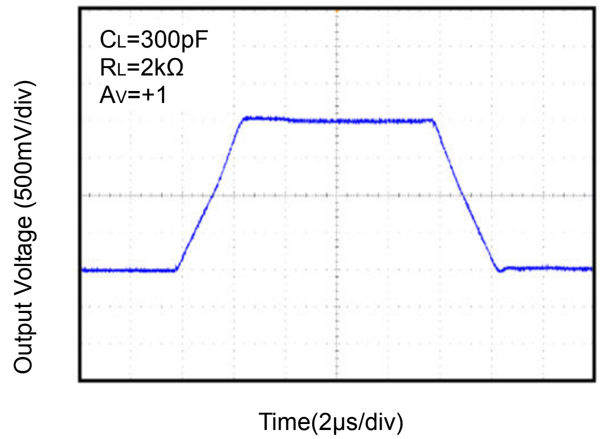
5.5 Typical Characteristics

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

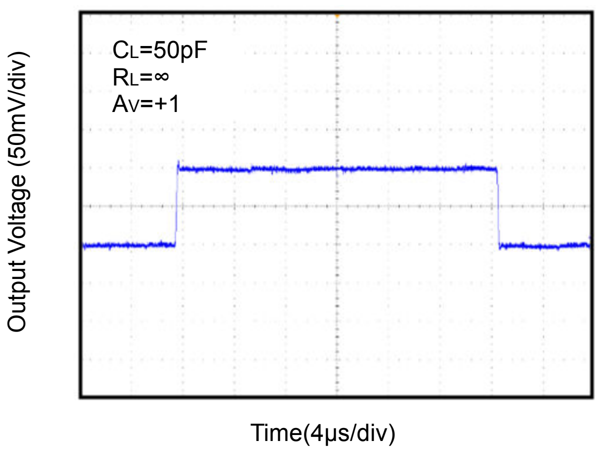
Large Signal Transient Response at +5V



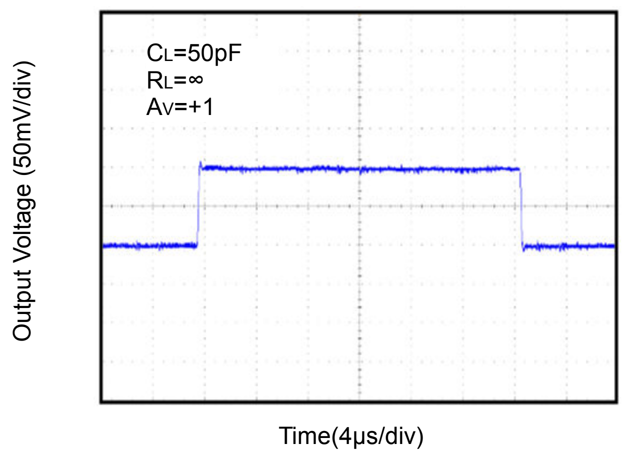
Large Signal Transient Response at +2.5V



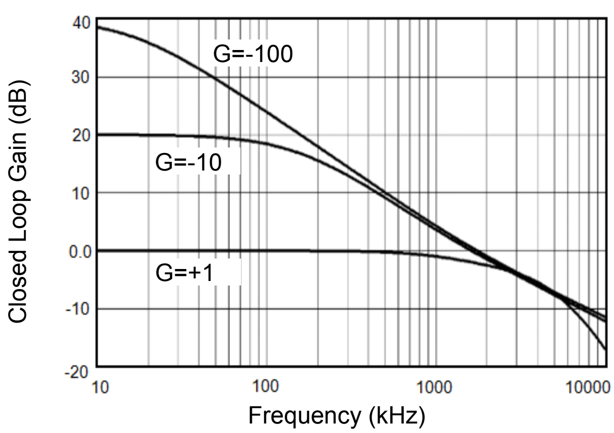
Small Signal Transient Response at +5V



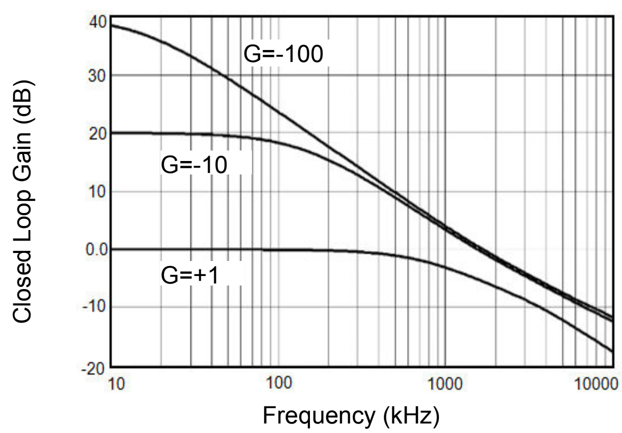
Small Signal Transient Response at +2.5V



Closed Loop Gain vs. Frequency at +5V



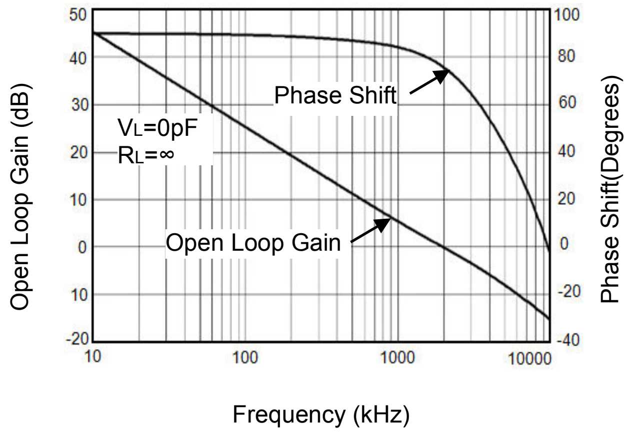
Closed Loop Gain vs. Frequency at +2.5V



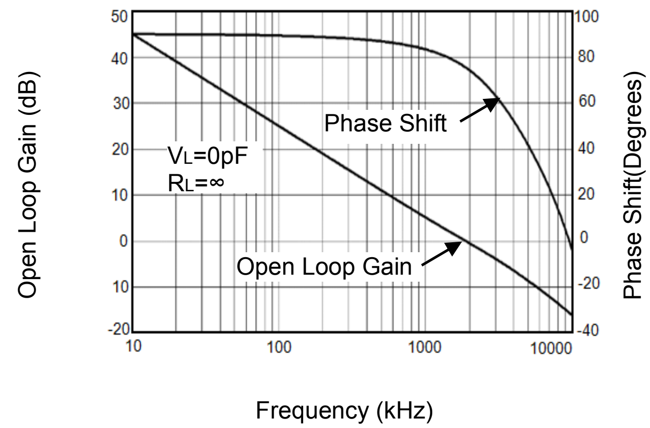
5.5 Typical Characteristics(continued)

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

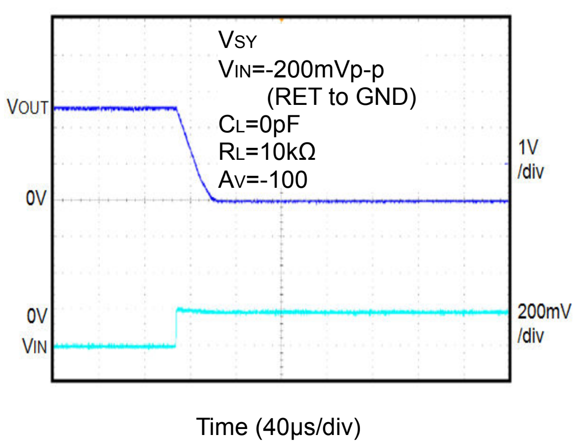
Open Loop Gain, Phase Shift vs. Frequency at +5V



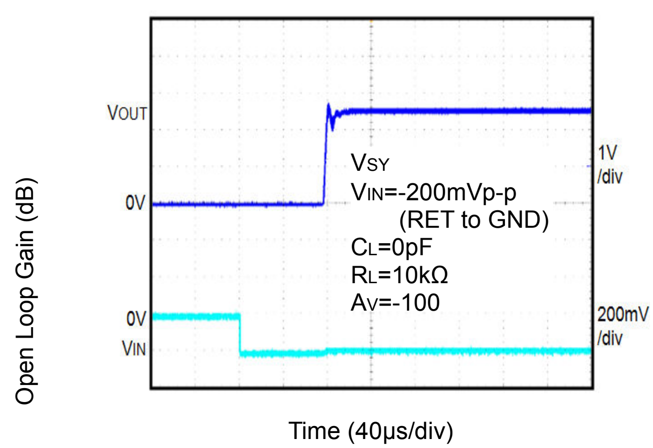
Open Loop Gain, Phase Shift vs. Frequency at +2.5V



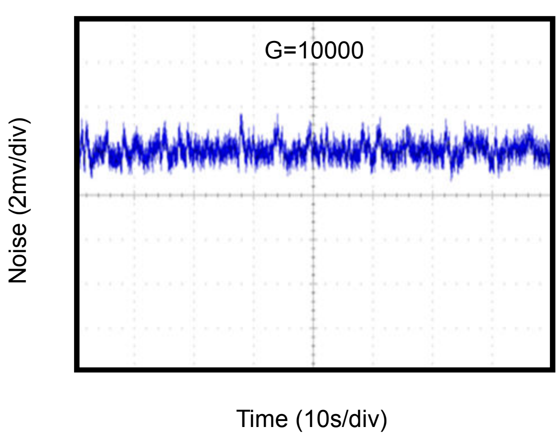
Positive Overvoltage Recovery



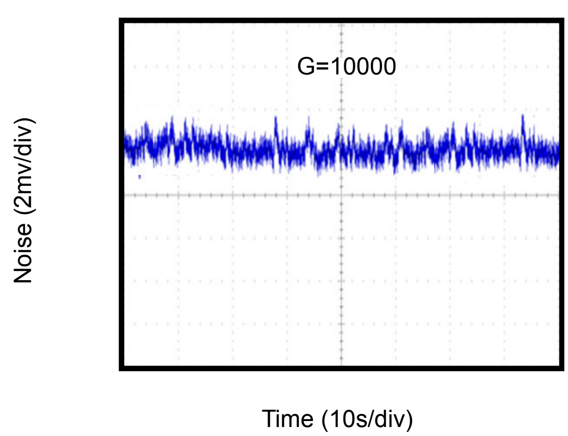
Negative Overvoltage Recovery



0.1Hz to 10Hz Noise at +5V



0.1Hz to 10Hz Noise at +2.5V



6 Application

Note

Size

MCOAX335Z series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the MCOAX335Z series packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

MCOAX335Z series operates from a single 1.8V to 5.5V supply or dual ±0.5V 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 220µA per channel) of MCOAX335Z series will help to maximize battery life. They are ideal for battery powered systems.

Operating Voltage

MCOAX335Z series operate under wide input supply voltage (1.8V to 5.5V). 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 MCOAX335Z 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 MCOAX335Z series can typically swing to less than 5mV from supply rail in light resistive loads (>100kΩ), and 60mV of supply rail in moderate resistive loads (10kΩ).

Capacitive Load Tolerance

The MCOAX335Z 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 amplifiers output and the load capacitance and (2) reducing the bandwidth of the amplifier's feedback loop by increasing the overall noise gain. Figure 2. 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.

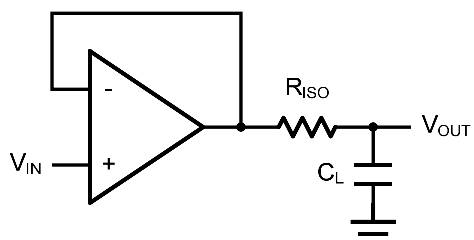


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

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 3 is an improvement to the one in Figure 2. 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 signalback to the amplifier ’ s inverting input, thereby preserving the phase margin in the overall fee dback loop. Capacitive drive can be increased by increasing the value of C_F. This in turn will slow down the pulse response.

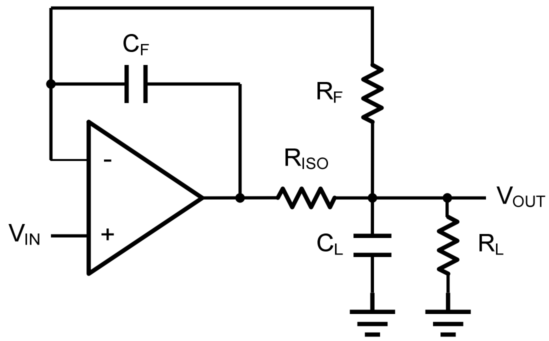


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

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6.1 Typical Application Circuits

6.1.1 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 4.shown the differential amplifier using MCOAX335Z.

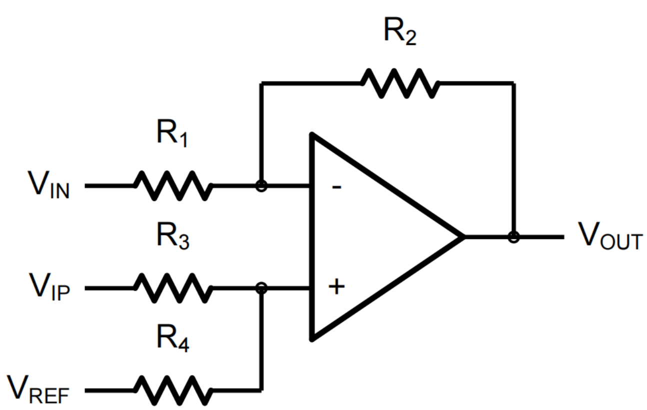


Figure 4. Differential Amplifier

$$V_{OUT}=\left(\frac{R_1+R_2}{R_3+R_4}\right)\frac{R_4}{R_1}V_{IN}-\frac{R2}{R1}V_{IP}+\left(\frac{R_1+R_2}{R_3+R_4}\right)\frac{R_3}{R_1}V_{REF}$$

If the resistor ratios are equal (i.e. R1=R3 and R2=R4), then

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

6.1.2 Low Pass Active Filter

The low pass active filter is shown in Figure 5. The DC gain is defined by $-R_2/R_1$. The filter has a -20dB/decade roll-off after its corner frequency $f_C=1/(2\pi R_3C_1)$.

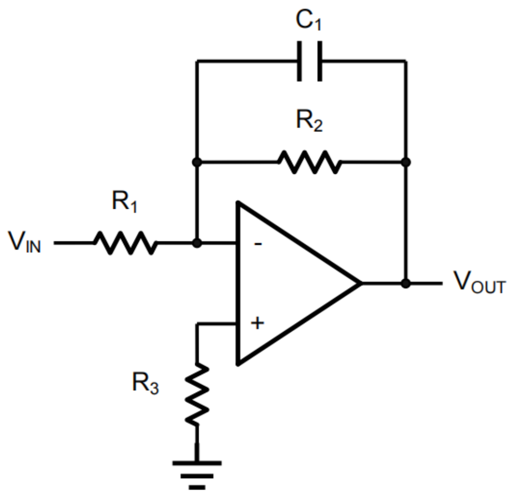


Figure 5. Low Pass Active Filter

6.1.3 Instrumentation Amplifier

The triple MCOAX335Z can be used to build a three-op-amp instrumentation amplifier as shown in Figure 6. The amplifier in Figure 6 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.

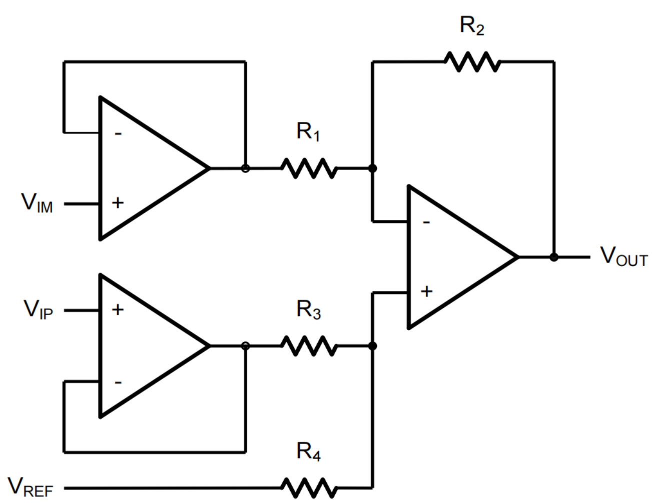
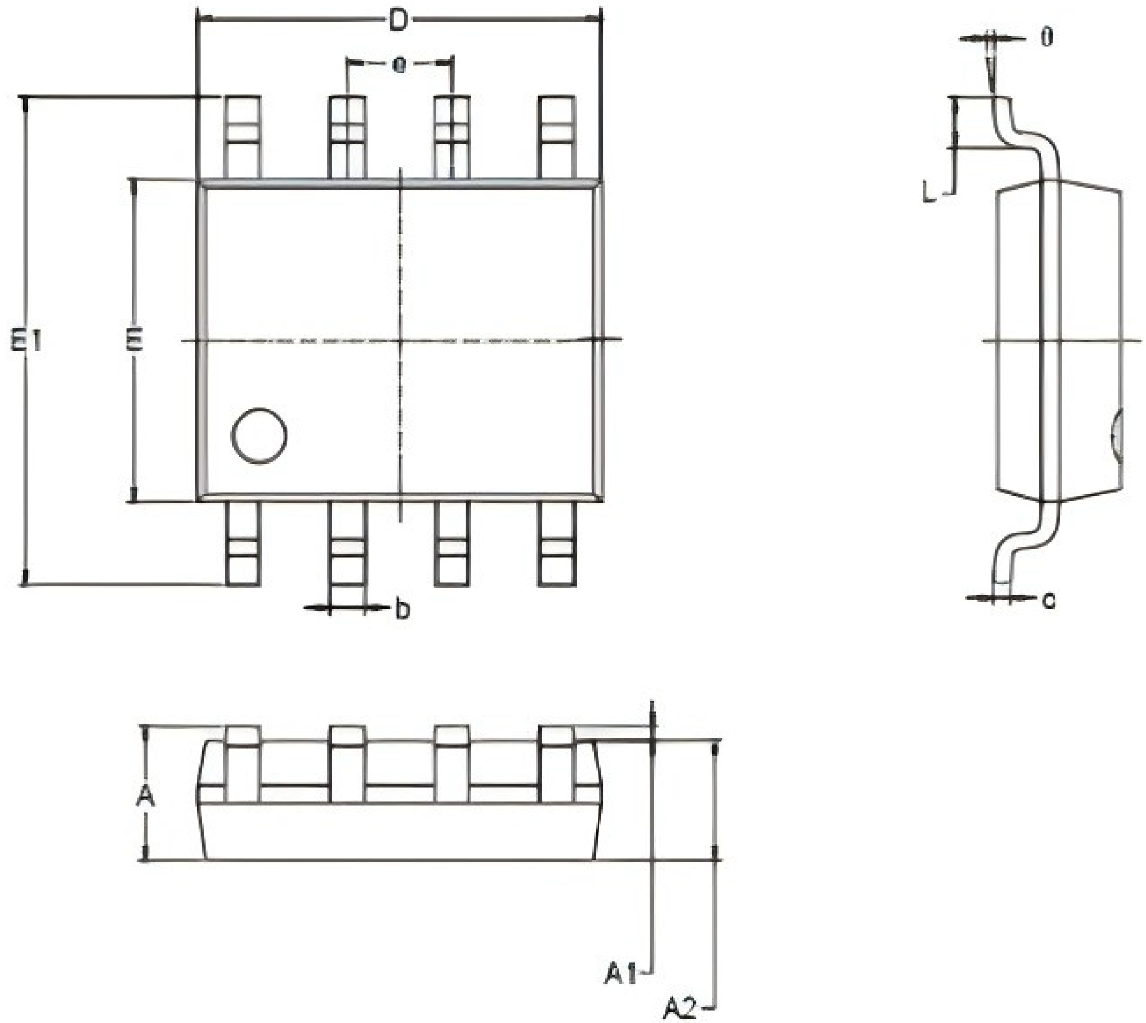
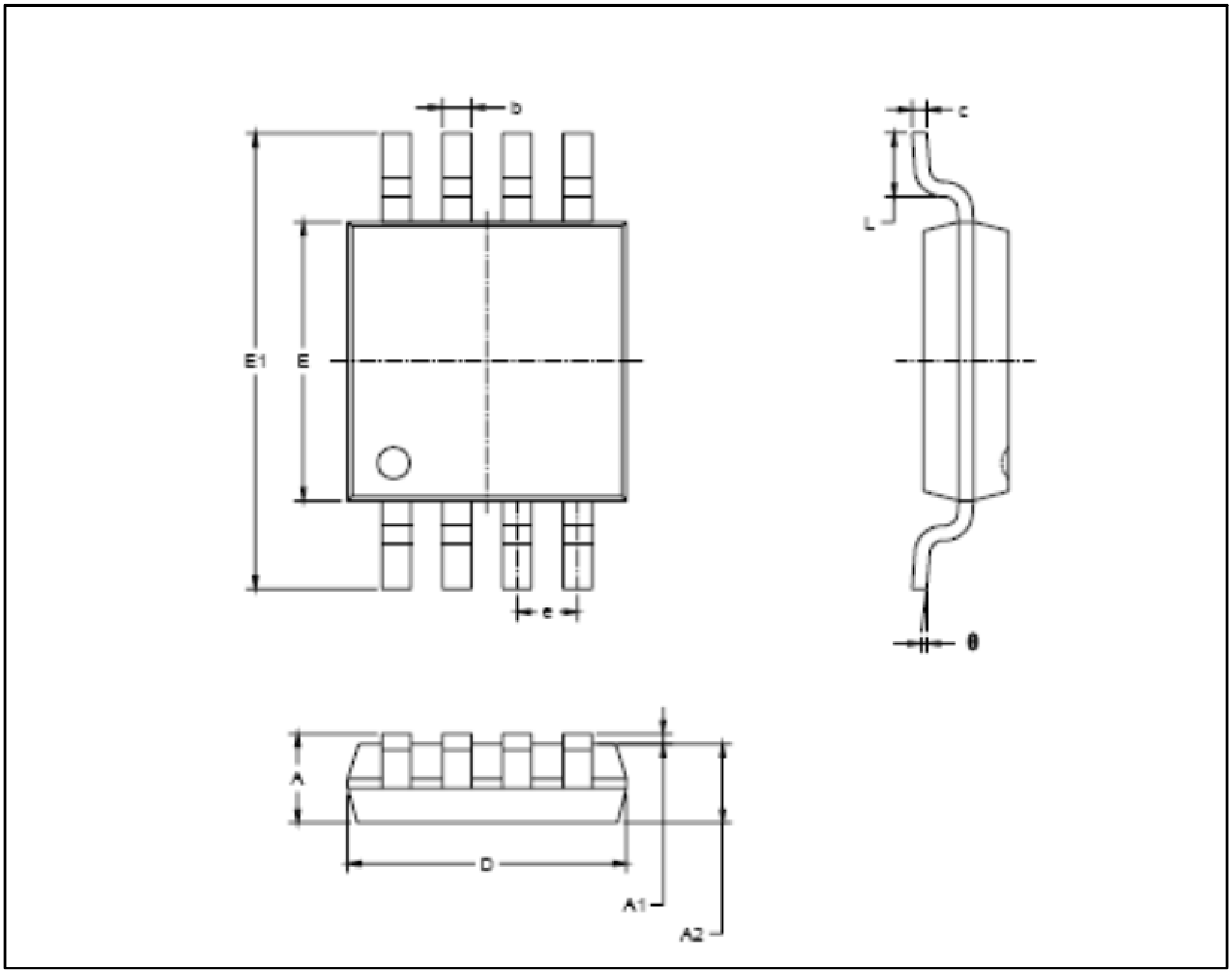


Figure 6. Instrument Amplifier

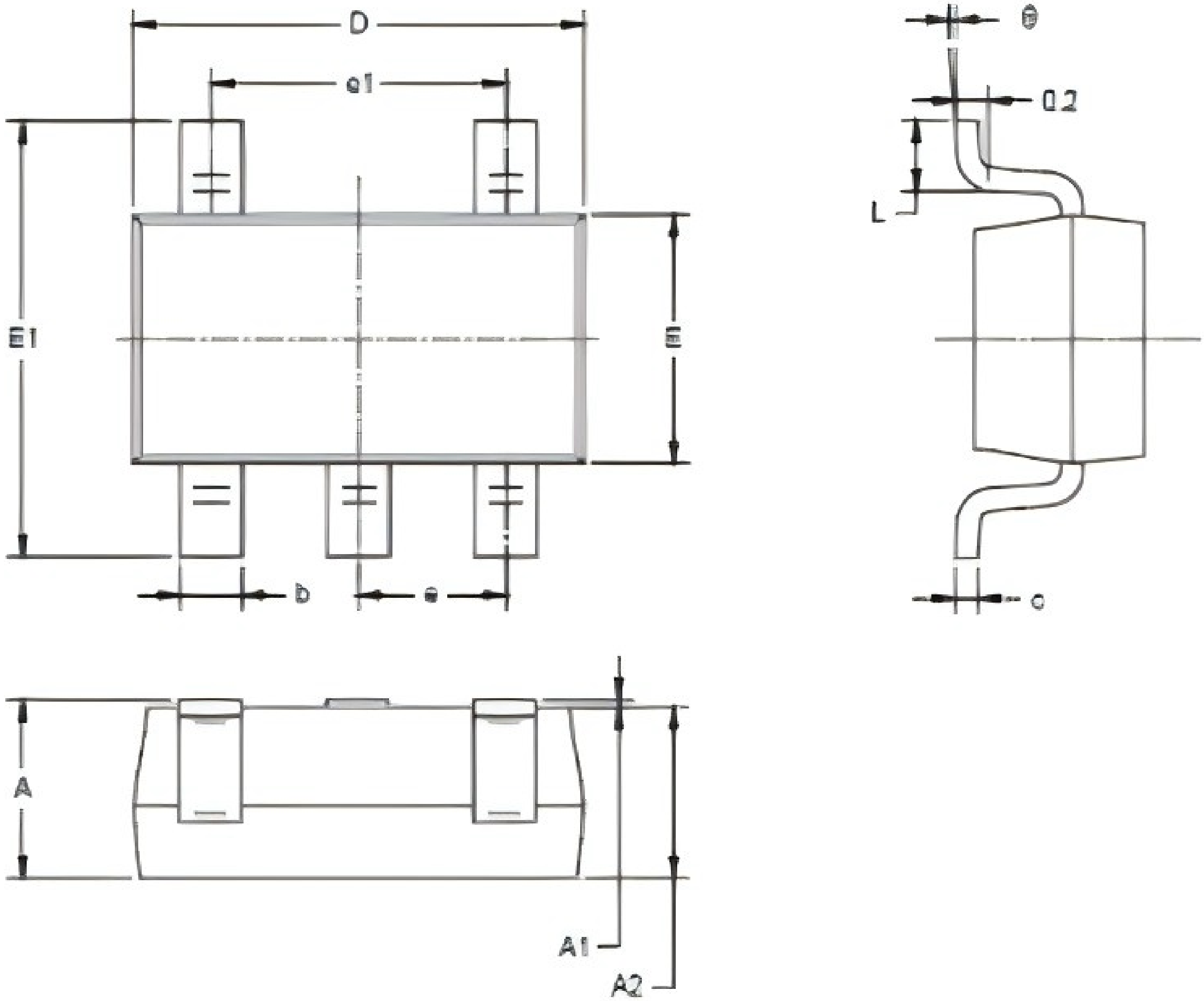
MODEL	CHANNEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
MCOA335Z	Single	MCOA335Z-TR	SOT23-5	Tape and Reel,3000	335Z
		MCOA335Z-SR	SOP-8	Tape and Reel,4000	MCOA335Z
MCOA2335Z	Dual	MCOA2335Z-SR	SOP-8	Tape and Reel,4000	MCOA2335Z
		MCOA2335Z-MR	MSOP-8	Tape and Reel,3000	MCOA2335Z
MCOA4335Z	Quad	MCOA4335Z-TR	TSSOP-8	Tape and Reel,3000	MCOA4335Z
		MCOA4335Z-SR	SOP-14	Tape and Reel,2500	MCOA4335Z



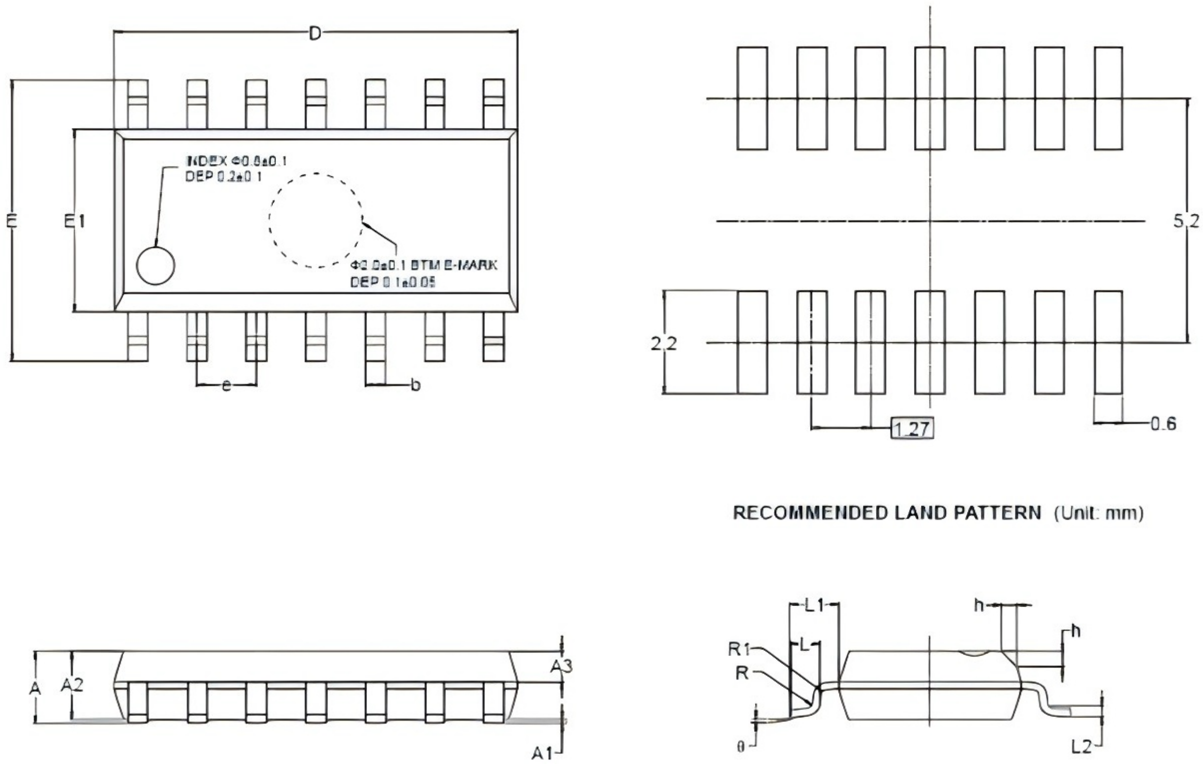
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.065
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 BSC		0.050BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°



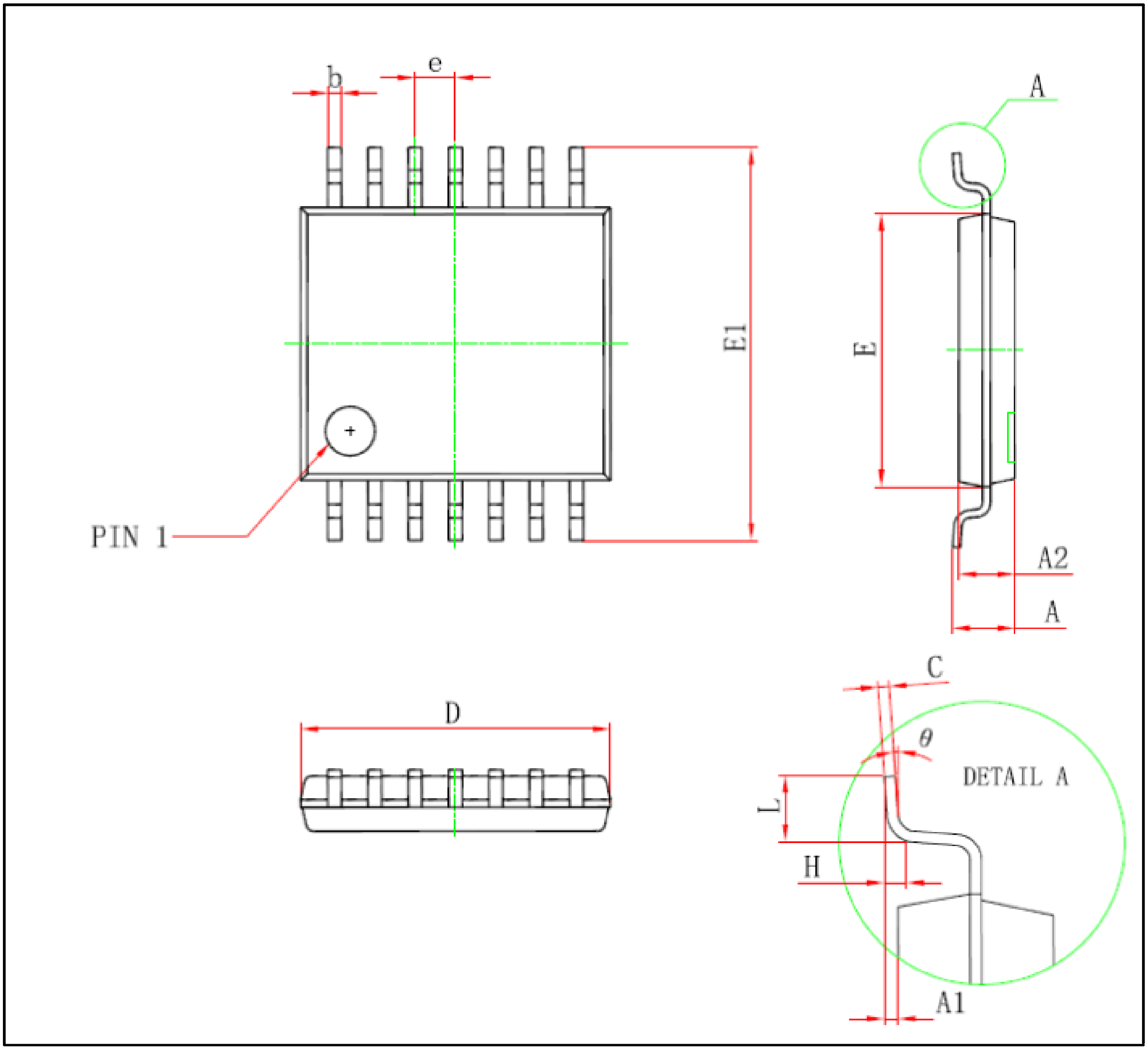
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°



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°



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	MIN	MOD	MAX	MIN	MOD	MAX
A	1.350		1.750	0.053		0.069
A1	0.100		0.250	0.004		0.010
A2	1.250		1.650	0.049		0.065
A3	0.550		0.750	0.022		0.030
b	0.360		0.490	0.014		0.019
D	8.530		8.730	0.336		0.344
E	5.800		6.200	0.228		0.244
E1	3.800		4.000	0.150		0.157
e		1.270 BSC			0.050 TYP	
L	0.450		0.800	0.018		0.032
L1		1.040 REF			0.040 REF	
L2		0.250 BSC			0.010 BSC	
R	0.070			0.003		
R1	0.070			0.003		
h	0.300		0.500	0.012		0.020
θ	0°		8°	0°		8°



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.020	0.028
H	0.250 TYP		0.010 TYP	
θ	1°	7°	1°	7°