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: 5µV (Max @25°C)**
- **Quiescent Current: 220µA per Amplifier (Typ)**
- **Operating Temperature: -45°C ~ +125°C**
- **Zero Drift: 0.005µV/^{o}C (Typ)**
- **Embedded RF Anti-EMI Filter**

Applications

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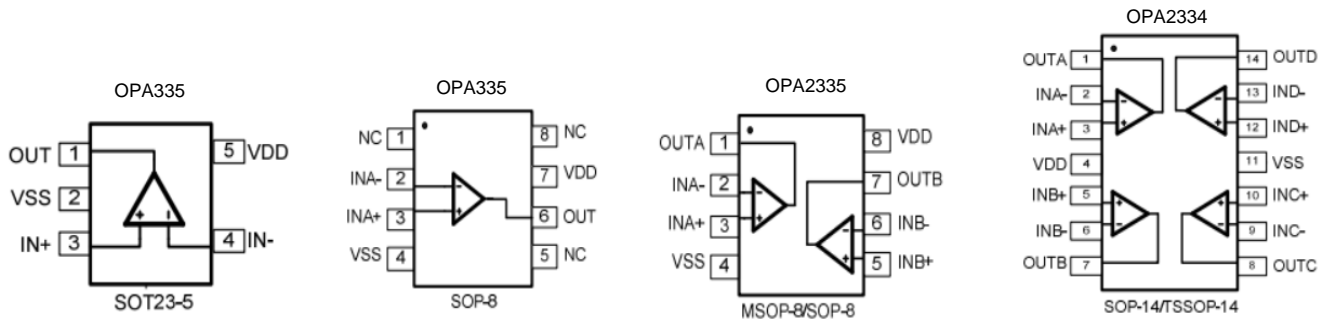- Battery-Powered Instrumentation

Pin Configuration

Figure 1. Pin Assignment Diagram

Absolute Maximum Ratings

Condition	Min	Max
Power Supply Voltage (V_{DD} to Vss)	-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℃)		
SOP-8, θ_{JA}	125°C/W	
MSOP-8, θ_{JA}	216°C/W	
SOT23-5, θ_{JA}	190°C/W	
ESD Susceptibility		
HBM	6KV	
MM	400V	

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.

Package/Ordering Information

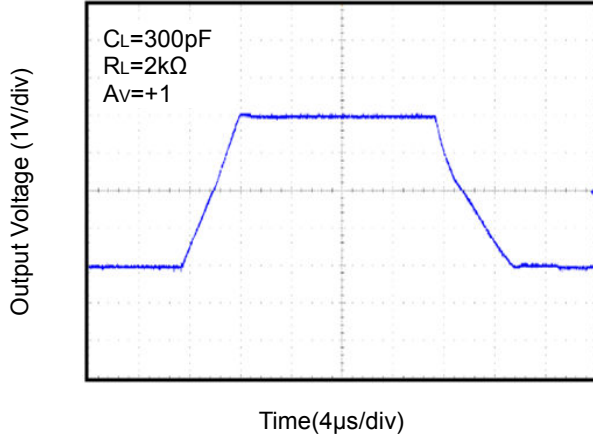| MODEL	CHANNEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
OPA335	Single	OPA335AIDB	SOT23-5	Tape and Reel,3000	335
		OPA335AID	SOP-8	Tape and Reel,4000	OPA335
OPA2335	Dual	OPA2335	SOP-8	Tape and Reel,4000	OPA2335
		OPA2335AIDG	MSOP-8	Tape and Reel,3000	OPA2335
OPA2334	Quad	OPA2334AIDB	TSSOP-14	Tape and Reel,3000	OPA2334
		OPA2334AID	SOP-14	Tape and Reel,2500	OPA2334

Electrical Characteristics

(V_S = +5V, V_{CM} = +2.5V, V_O = +2.5V, T_A = +25℃, unless otherwise noted.)
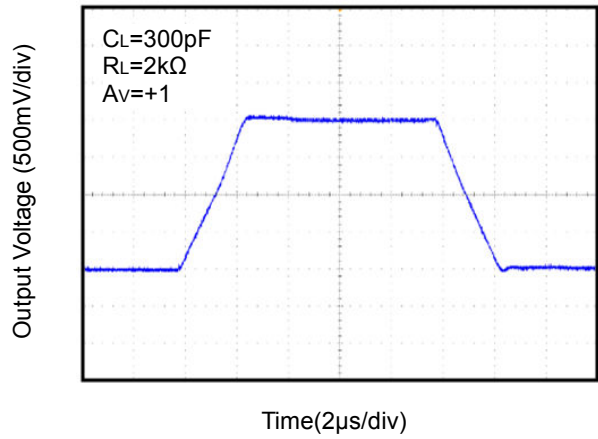
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS					
Input Offset Voltage (V_{OS})			1	5	µV
Input Bias Current (I_B)			20		pA
Input Offset Current (I_{OS})			10		pA
Common-Mode Rejection Ratio (CMRR)	V_{CM} = 0V to 5V		110		dB
Large Signal Voltage Gain (A_{VO})	R_L = 10kΩ, V_O = 0.3V to 4.7V		145		dB
Input Offset Voltage Drift ($\Delta V_{OS}/\Delta_T$)			5	50	nV/℃
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		$nV/\sqrt{Hz}$

Typical Performance characteristics
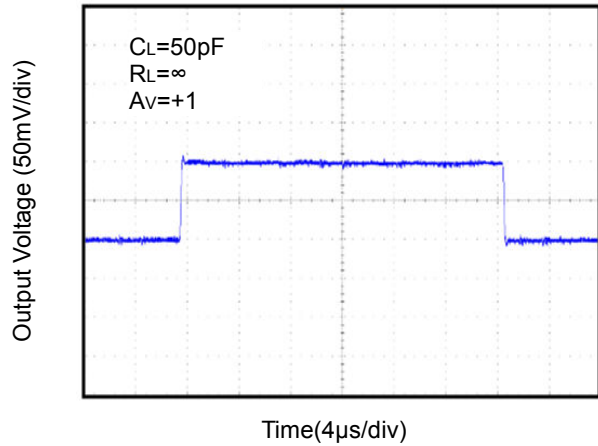
Large Signal Transient Response at +5V

C_L=300pF
R_L=2kΩ
A_V=+1

Output Voltage (1V/div)

Time(4μs/div)

Large Signal Transient Response at +2.5V

C_L=300pF
R_L=2kΩ
A_V=+1

Output Voltage (500mV/div)

Time(2μs/div)

Small Signal Transient Response at +5V

C_L=50pF
R_L=∞
A_V=+1

Output Voltage (50mV/div)

Time(4μs/div)

Small Signal Transient Response at +2.5V

C_L=50pF
R_L=∞
A_V=+1

Output Voltage (50mV/div)

Time(4μs/div)

Closed Loop Gain vs. Frequency at +5V

Closed Loop Gain (dB)

G=-100
G=-10
G=+1
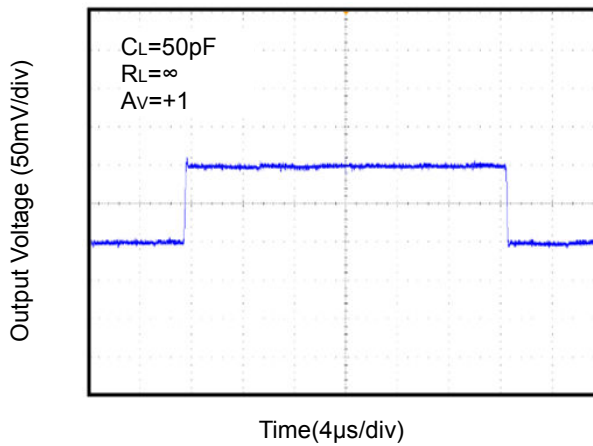
Frequency (kHz)

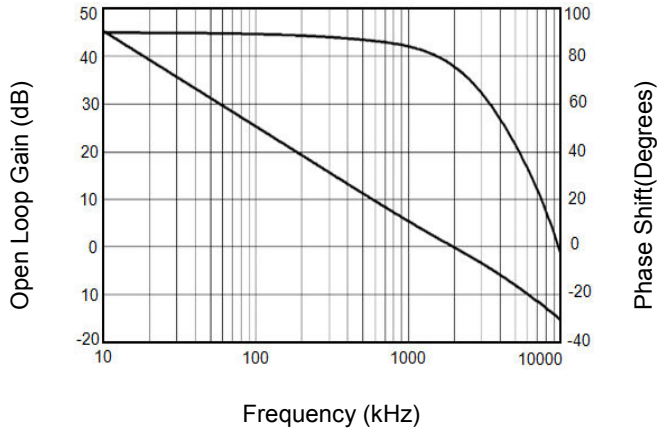### Closed Loop Gain vs. Frequency at +2.5V

Closed Loop Gain (dB)

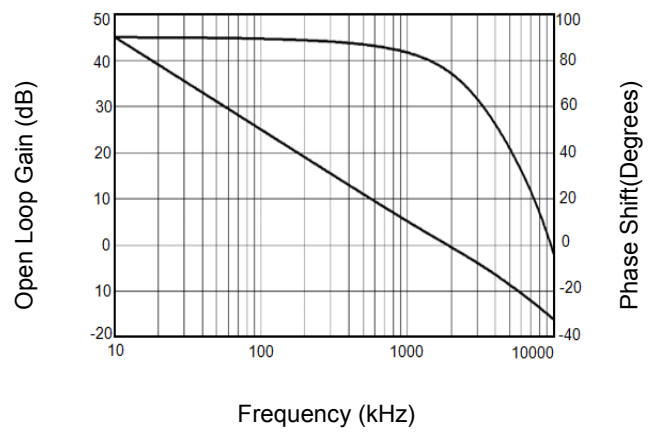G=-100
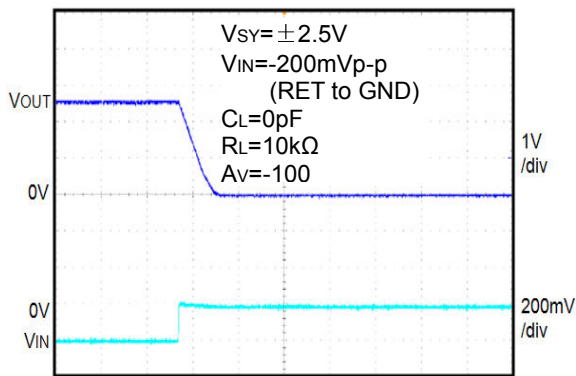G=-10
G=+1
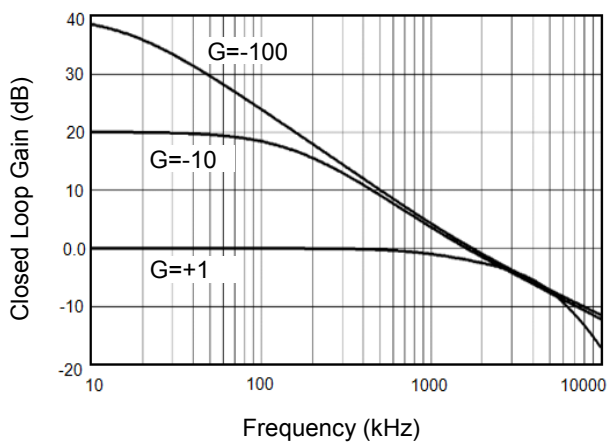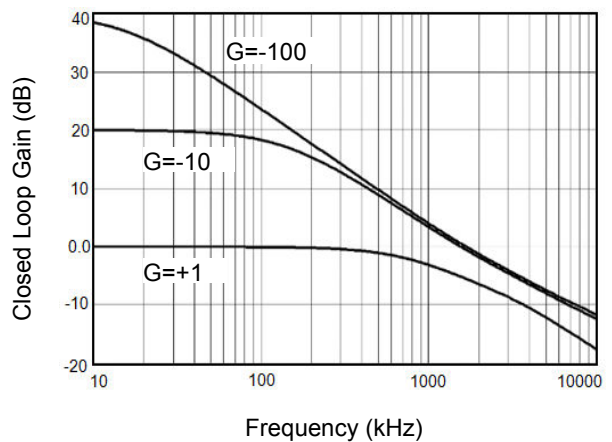
Frequency (kHz)

Typical Performance characteristics

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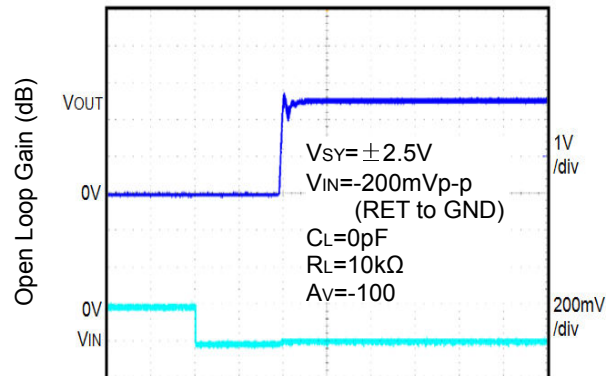

Open Loop Gain, Phase Shift
vs. Frequency at +2.5V
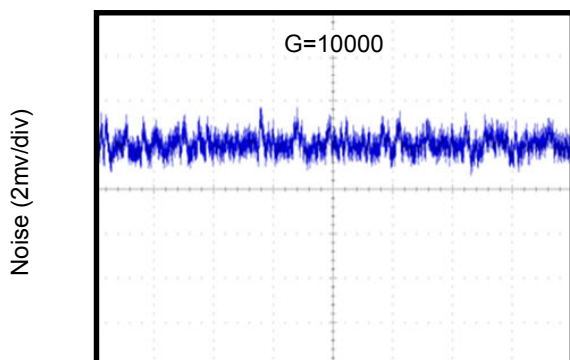

Positive Overvoltage Recovery

$V_{SY}=\pm2.5V$
$V_{IN}=-200mVp\text{-}p$
(RET to GND)
$C_L=0pF$
$R_L=10k\Omega$
$A_V=-100$

Negative Overvoltage Recovery

$V_{SY}=\pm2.5V$
$V_{IN}=-200mVp\text{-}p$
(RET to GND)
$C_L=0pF$
$R_L=10k\Omega$
$A_V=-100$

0.1Hz to 10Hz Noise at +5V

G=10000

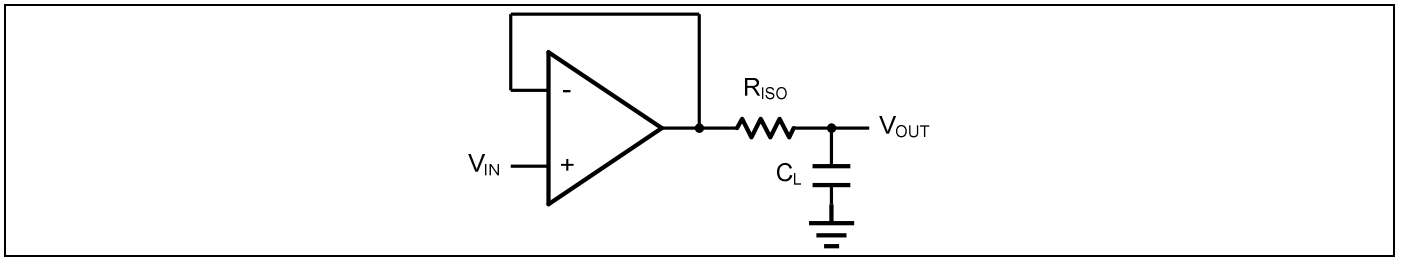0.1Hz to 10Hz Noise at +2.5V

G=10000
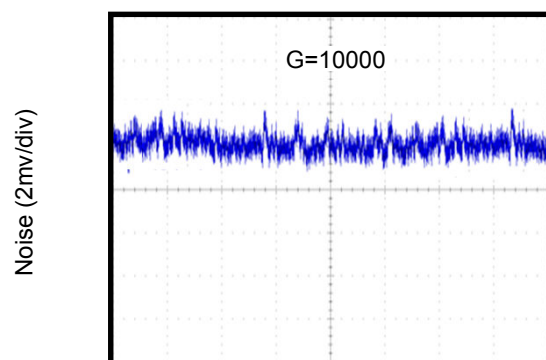
Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

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 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.
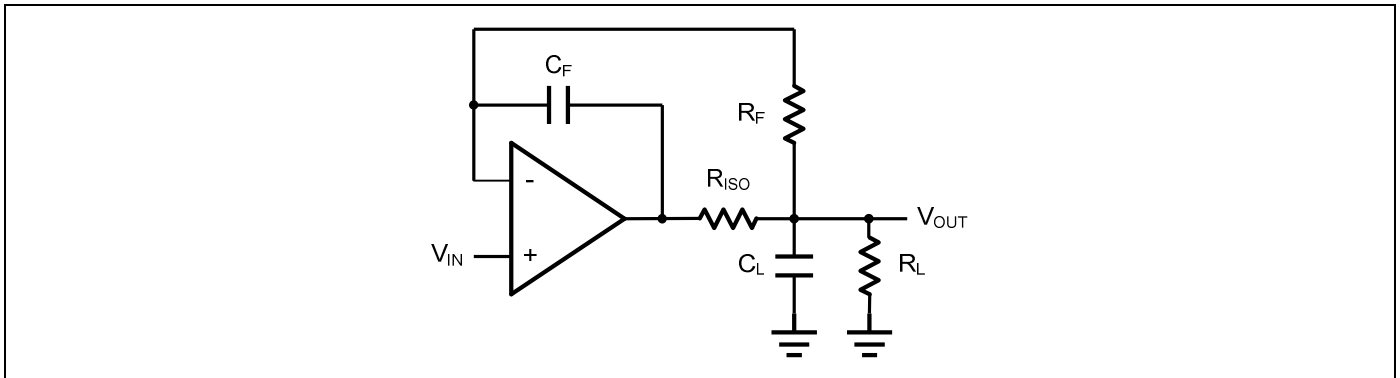
Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

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 4. shown the differential amplifier using OPA335/2335/2334.
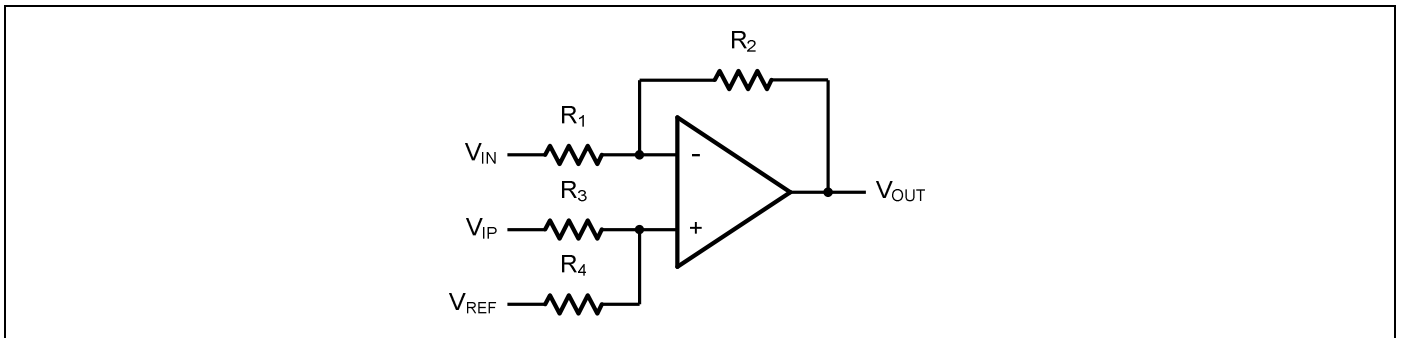

Figure 4. Differential Amplifier

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

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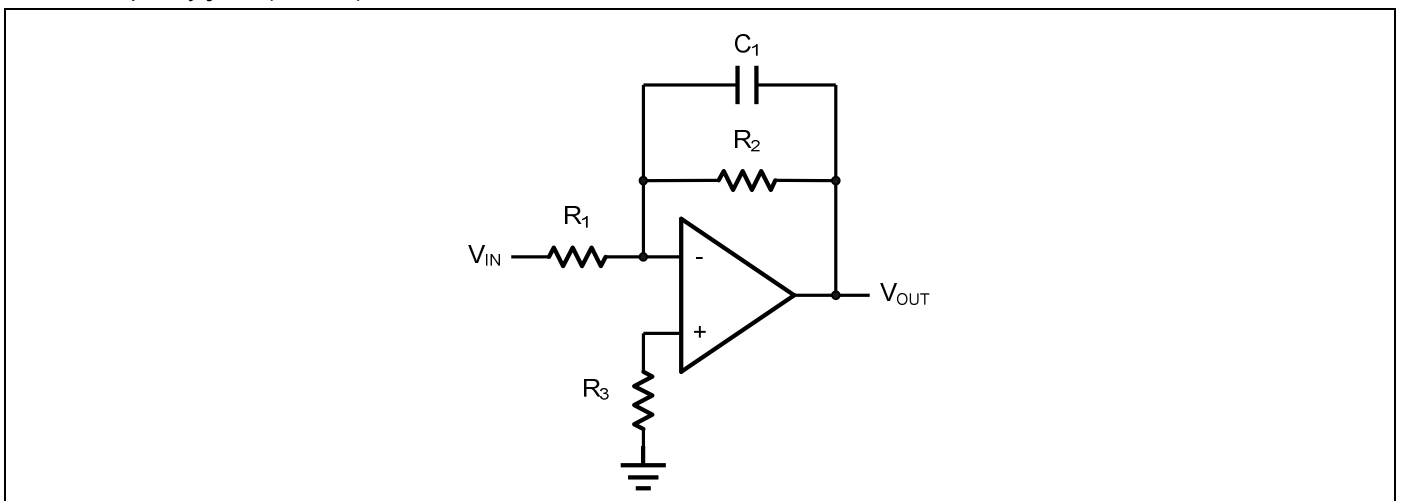

Figure 5. Low Pass Active Filter

Instrumentation Amplifier

The triple OPA335/2335/2334 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 R2/R1. The two differential voltage followers assure the high input impedance of the amplifier.
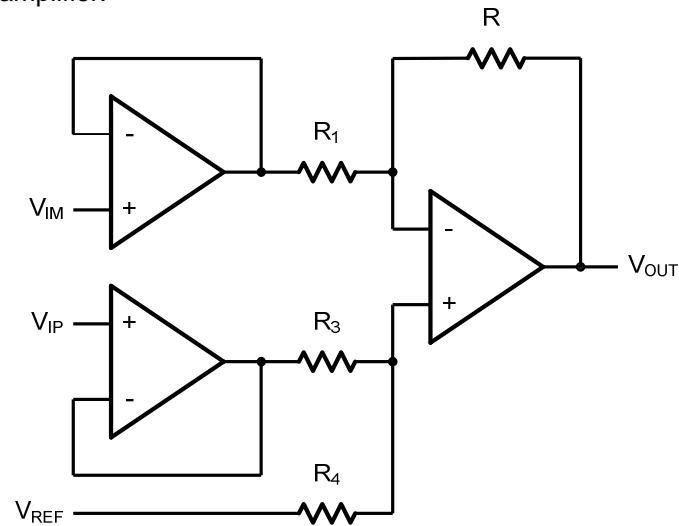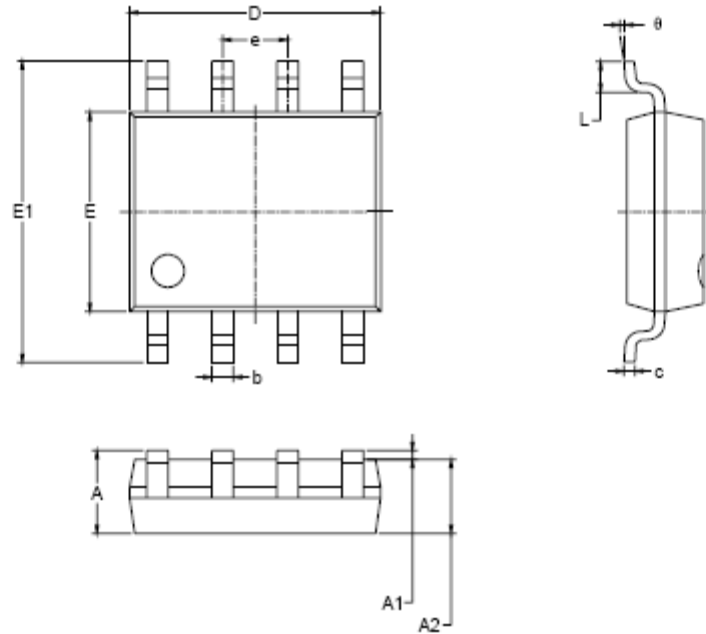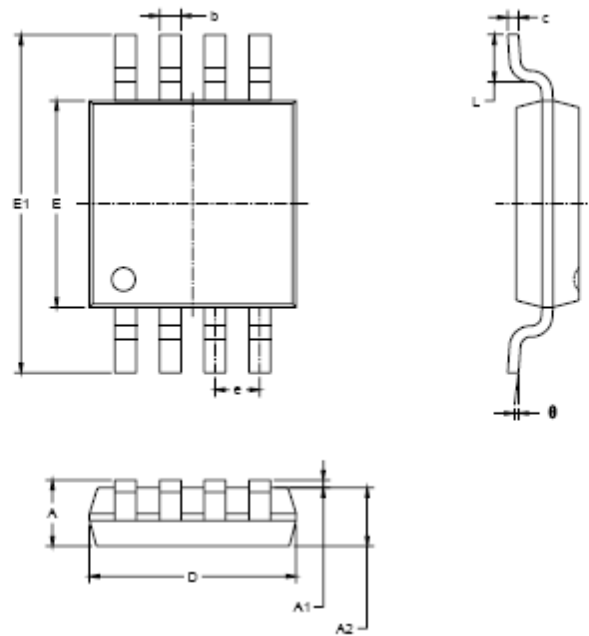
Figure 6. Instrument Amplifier

Package Information

SOP-8

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
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	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

MSOP-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°

SOT23-5
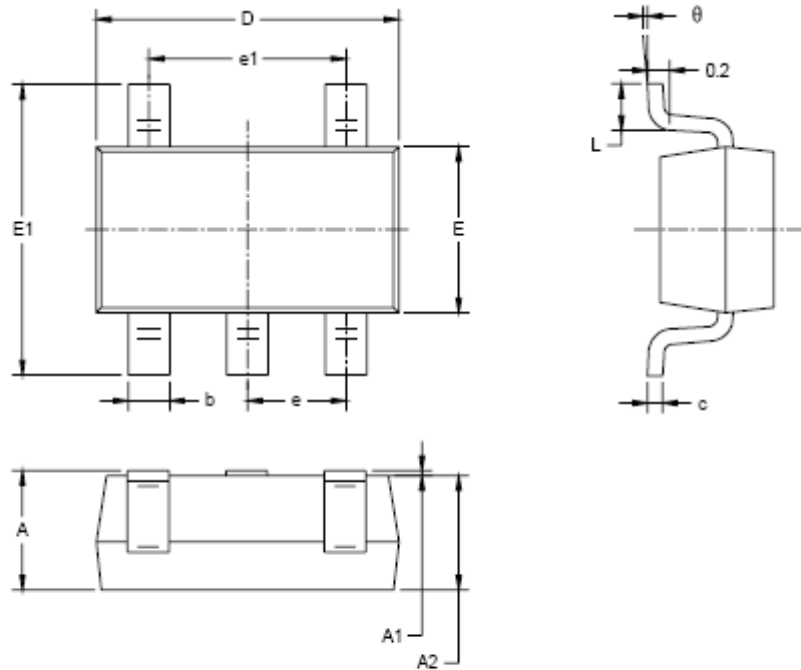
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

SOP-14
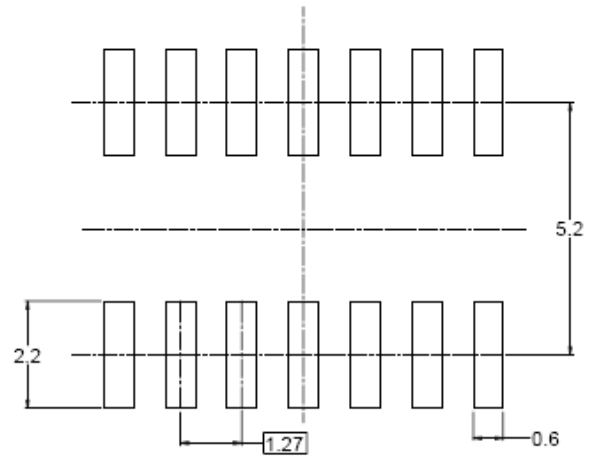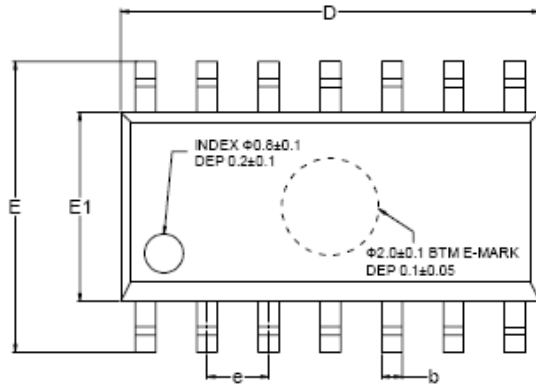
RECOMMENDED LAND PATTERN (Unit: mm)
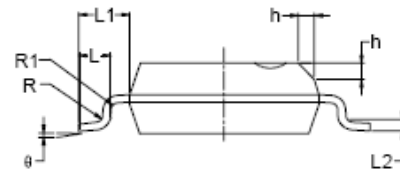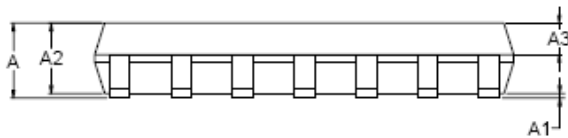
Symbol	Dimensions In Millimeters			Dimensions In Inches		
	MIN	MOD	MAX	MIN	MOD	MAX
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
A2	1.25		1.65	0.049		0.065
A3	0.55		0.75	0.022		0.030
b	0.36		0.49	0.014		0.019
D	8.53		8.73	0.336		0.344
E	5.80		6.20	0.228		0.244
E1	3.80		4.00	0.150		0.157
e	1.27 BSC			0.050 BSC		
L	0.45		0.80	0.018		0.032
L1	1.04 REF			0.040 REF		
L2	0.25 BSC			0.01 BSC		
R	0.07			0.003		
R1	0.07			0.003		
h	0.30		0.50	0.012		0.020
θ	0°		8°	0°		8°

TSSOP-14
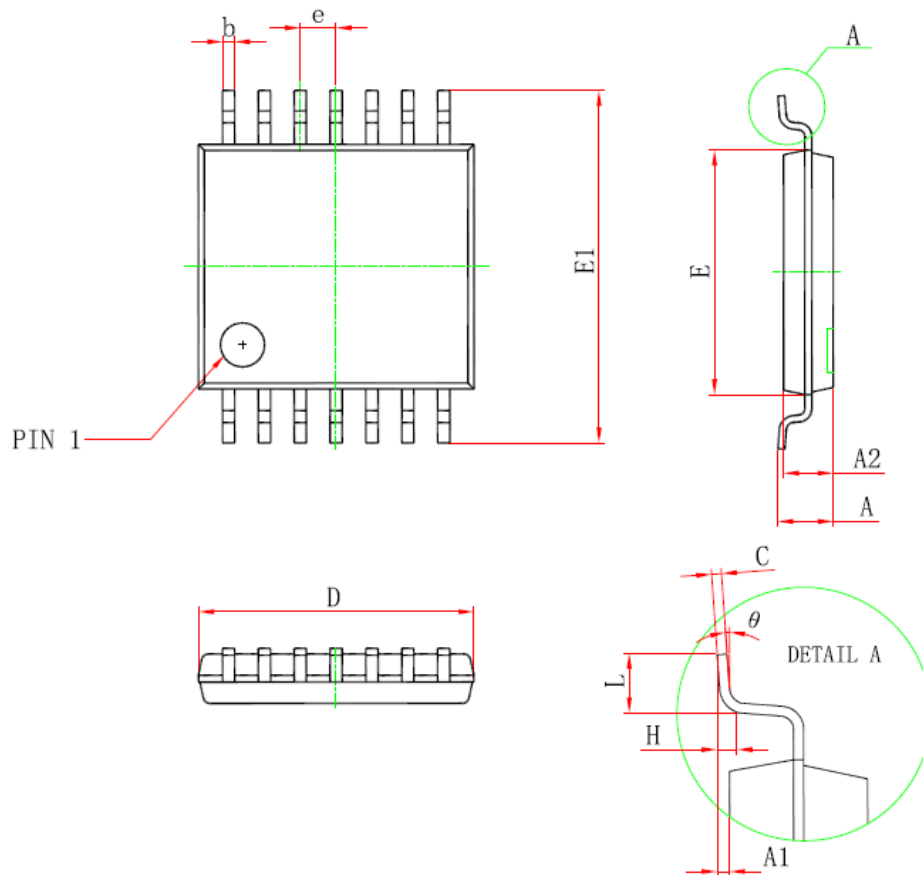
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.65 (BSC)		0.026 (BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°