DESCRIPTION

The AO324V have a high gain-bandwidth product of 1MHz, a slew rate of 0.6V/μs, and a quiescent current of 40μA/amplifier at 5V. The AO324V is designed to provide optimal performance in low voltage and low noise systems. They provide rail-to-rail output swing into heavy loads. The input common mode voltage range includes ground, and the maximum input offset voltage is 3.5mV for AO324V. They are specified over the extended industrial temperature range (-40℃ to +125℃). The operating range is from 2.1V to 5.5V.

The AO324V (quad) is available in SOP14 package.

ORDERING INFORMATION

Package Type	Part Number	
SOP14 SPQ: 2,500pcs/Reel	M14	AO324VM14R
		AO324VM14VR
Note	V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products		

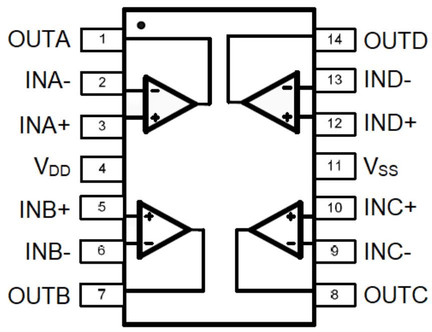
FEATURES

- Single-Supply Operation from +2.1V ~ +5.5V
- Rail-to-Rail Input / Output
- Gain-Bandwidth Product: 1MHz (Typ.)
- Low Input Bias Current: 1pA (Typ.)
- Low Offset Voltage: 3.5mV (Max.)
- Quiescent Current: 40μA per Amplifier (Typ.)
- Operating Temperature: -40°C ~ +125°C
- Embedded RF Anti-EMI Filter
- Available in SOP14 package

APPLICATION

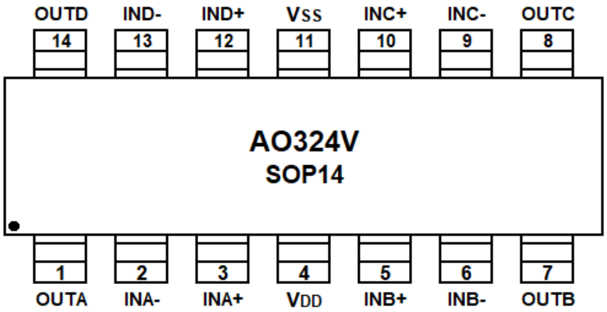
- ASIC Input or Output Amplifier
- Sensor Interface
- Medical Communication
- Smoke Detectors
- Audio Output
- Piezoelectric Transducer Amplifier
- Medical Instrumentation
- Portable Systems

TYPICAL APPLICATION



SOP14

PIN DESCRIPTION



Top View

Pin #	Symbol	Function
1	OUTA	Output A
2	INA+	Analog Positive Input A
3	INA-	Analog Inverting Input A
4	V_{DD}	Positive Power Supply Input
5	INB+	Analog Positive Input B
6	INB-	Analog Inverting Input B
7	OUTB	Output B
8	OUTC	Output C
9	INC-	Analog Inverting Input C
10	INC+	Analog Positive Input C
11	V_{SS}	Ground or Negative Power Supply Input
12	IND+	Analog Positive Input D
13	IND-	Analog Inverting Input D
14	OUTD	Output D

ABSOLUTE MAXIMUM RATINGS

Power Supply Voltage (V_{DD} to V_{SS})	-0.5V~+7.5V
Analog Input Voltage (IN+ or IN-)	V_{SS}-0.5V~V_{DD}+0.5V
PDB Input Voltage	V_{SS}-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
ESD Susceptibility	
HBM	6kV
MM	300V

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.

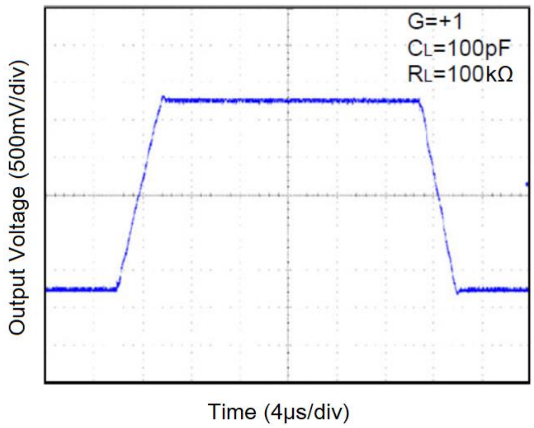
Parameter	Symbol	Conditions	Typ +25°C	Min/Max Over Temperature +25°C	-40°C to +85°C	Unit	Min / Max
INPUT CHARACTERISTICS							
Input Offset Voltage	V_{OS}	V_{CM} = $V_S/2$	0.4	3.5	5.6	mV	Max
Input Bias Current	I_B		1	-	-	pA	Typ
Input Offset Current	I_{OS}		1	-	-	pA	Typ
Common-Mode Voltage Range	V_{CM}	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		
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		
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	4.990	4.980	V	Min
	V_{OL}	R_L = 100kΩ	3	10	20	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			-	2.1	2.5	V	Min
			-	5.5	5.5	V	Max
Power Supply Rejection Ratio	PSRR	V_S = +2.5V to +5.5V, V_{CM} = +0.5V	82	60	58	dB	Min
Quiescent Current/Amplifier	I_Q		40	-	-	μA	Typ

Parameter	Symbol	Conditions	Typ	Min/Max Over Temperature			
			+25℃	+25℃	-40℃ to +85℃	Unit	Min / Max
DYNAMIC PERFORMANCE (C_L = 100pF)							
Gain-Bandwidth Product	GBP		1	-	-	MHz	Typ
Slew Rate	SR	G = +1, 2V Output Step	0.6	-	-	V/μs	Typ
Settling Time to 0.1%	t_S	G = +1, 2V Output Step	5	-	-	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/√Hz	Typ
		f = 10kHz	20	-	-	nV/√Hz	Typ

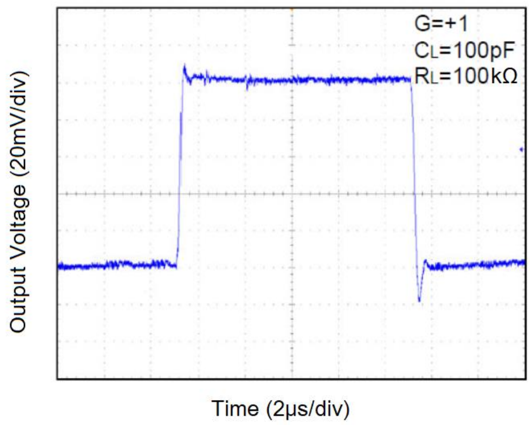
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A=+25°C, V_S=+5V, and R_L=100kΩ connected to V_S/2, unless otherwise noted.

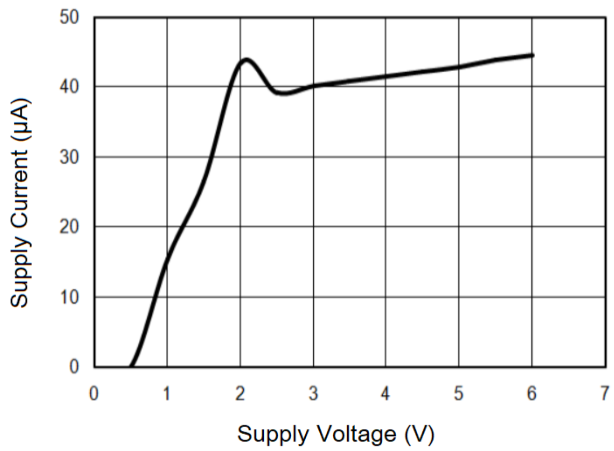
1. Large-Signal Step Response



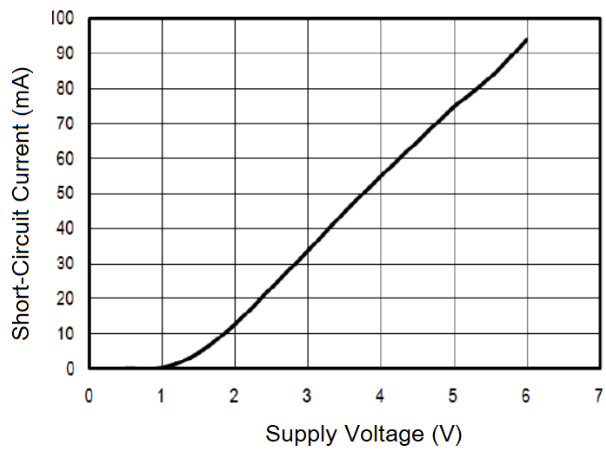
2. Small-Signal Step Response



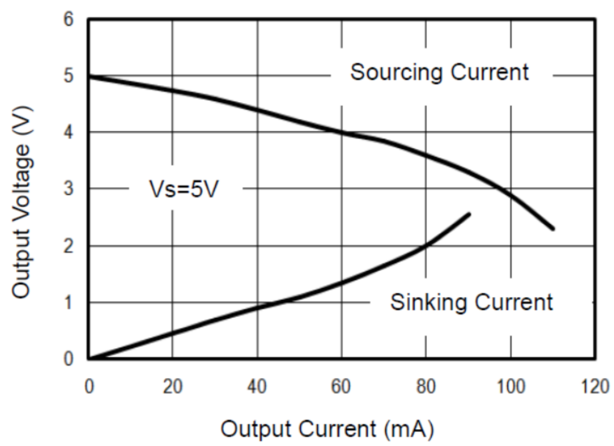
3. Supply Current vs. Supply Voltage



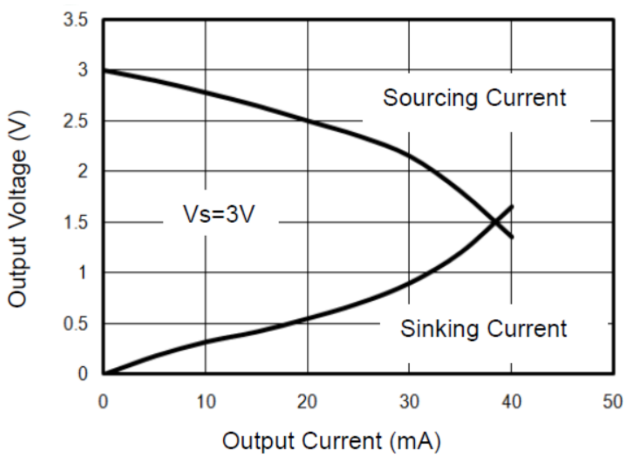
4. Short-Circuit Current vs. Supply Voltage



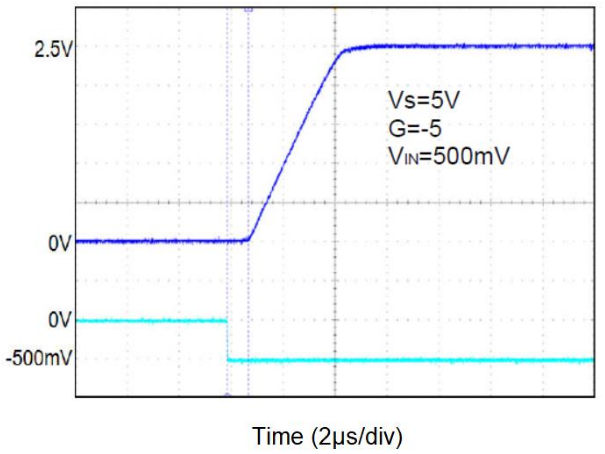
5. Output Voltage vs. Output Current



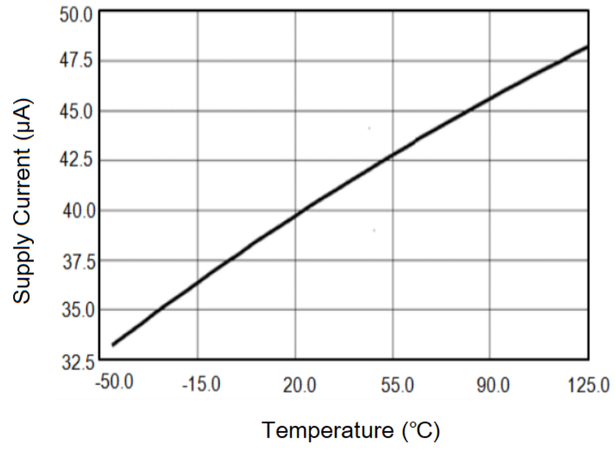
6. Output Voltage vs. Output Current



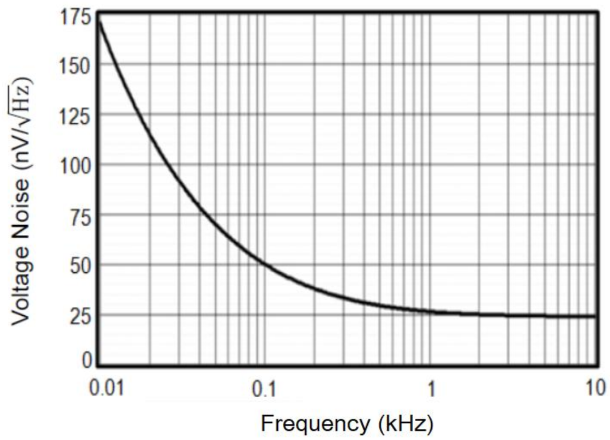
7. Overload Recovery Time



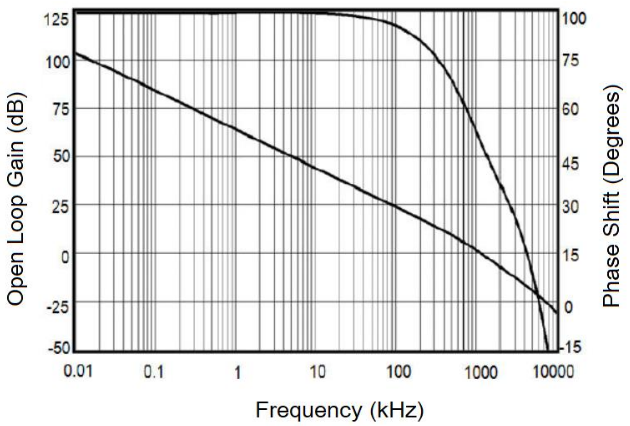
8. Supply Current vs. Temperature



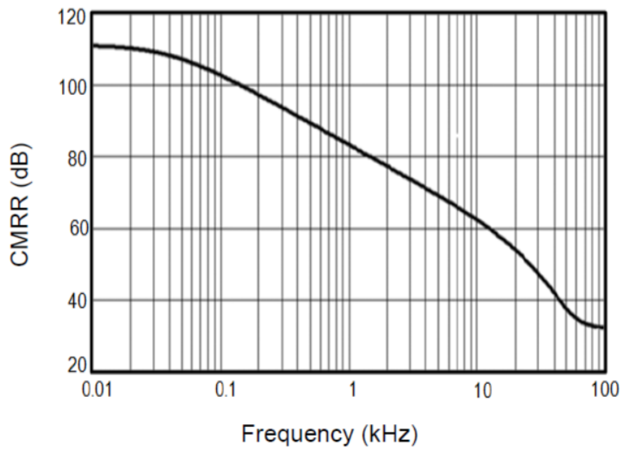
9. Input Voltage Noise Spectral Density vs. Frequency



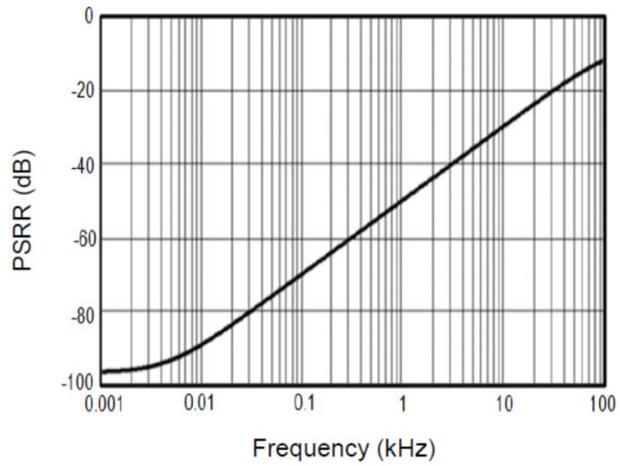
10. Open Loop Gain, Phase Shift vs. Frequency at +5V



11. CMRR vs. Frequency



12. PSRR vs. Frequency



DETAILED INFORMATION

Size

AO324V op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the AO324V packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

AO324V operates from a single 2.1V to 5.5V supply or dual ±1.05V 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 40uA per channel) of AO324V will help to maximize battery life. They are ideal for battery powered systems

Operating Voltage

AO324V operates under wide input supply voltage (2.1V 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 AO324V 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 AO324V can typically swing to less than 5mV from supply rail in light resistive loads (>100kΩ), and 30mV of supply rail in moderate resistive loads (10kΩ).

Capacitive Load Tolerance

The AO324V 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. 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.

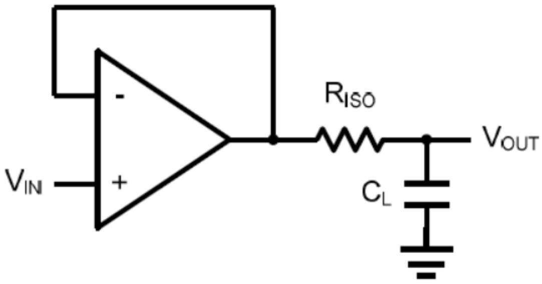


Figure 1. Indirectly Driving a Capacitive Load Using Isolation Resistor

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.

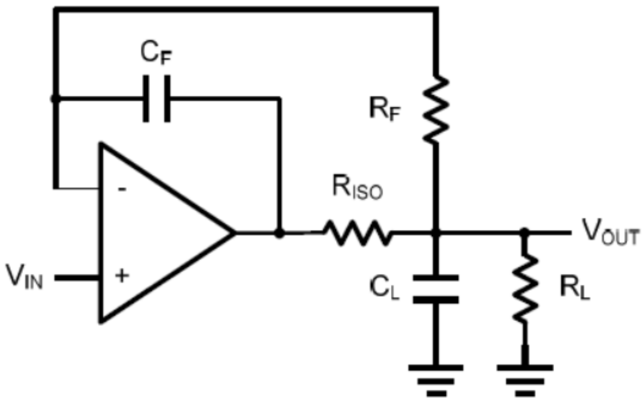


Figure 2. Indirectly Driving a Capacitive Load with DC Accuracy

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 AO324V.

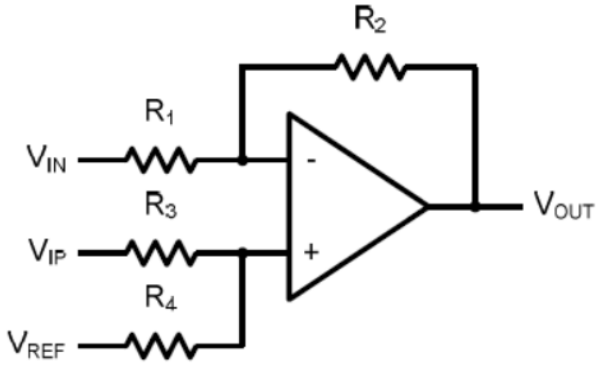


Figure 3. Differential Amplifier

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

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 $f_C=1/(2\pi R_3C_1)$.

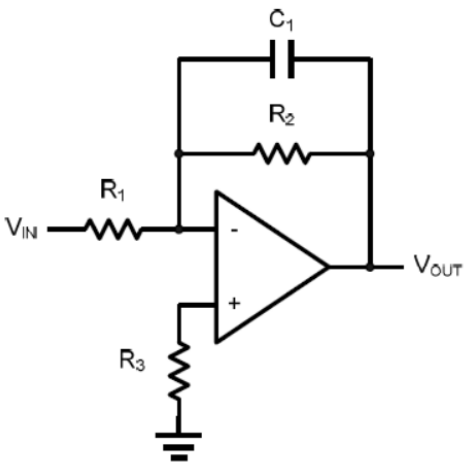


Figure 4. Low Pass Active Filter

Instrumentation Amplifier

The triple AO324V 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.

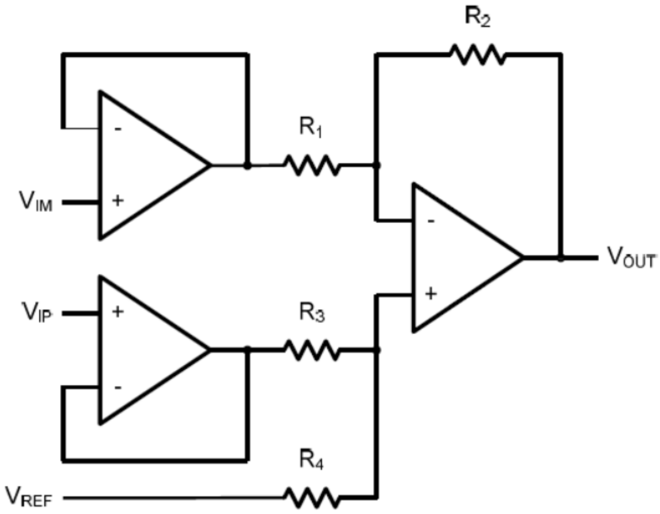
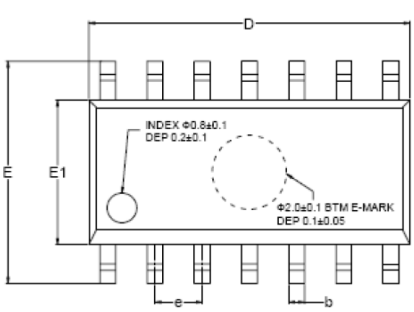
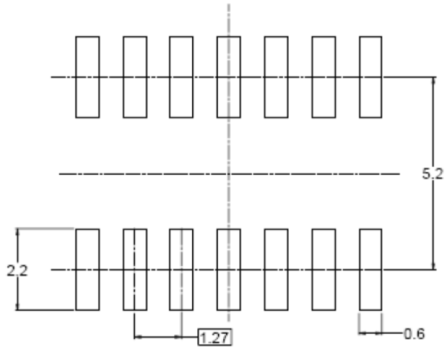


Figure 5. Instrument Amplifier

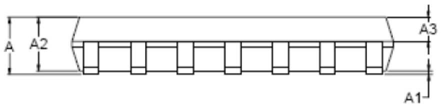
PACKAGE INFORMATION

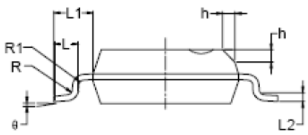
Dimension in SOP14 (Unit: mm)





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Millimeters		Inches	
	Min.	Max.	Min.	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		0.010 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°

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