DESCRIPTION

The AO324 consist of four independent high-gain frequency-compensated operational amplifier that is designed specifically to operate from a single supply or split supply over a wide range of voltages.

The AO324 has a high gain-bandwidth product of 1MHz, a slew rate of 0.2V/μs, and a quiescent current of 250μA/amplifier at 5V. The AO324 is designed to provide optimal performance in low voltage and low noise systems. The maximum input offset voltage is 5mV for AO324.

The AO324 is available in SOP14 package.

ORDERING INFORMATION

Package Type	Part Number	
SOP14 SPQ: 2,500pcs/Reel	M14	AO324M14R
		AO324M14VR
Note	V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products		

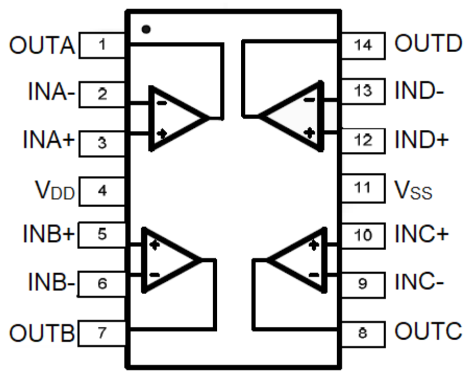
FEATURES

- Single-Supply Operation from +3V ~ +36V
- Dual-Supply Operation from ±1.5V ~ ±18V
- Gain-Bandwidth Product: 1MHz (Typ)
- Low Input Bias Current: 20nA (Typ)
- Low Offset Voltage: 5mV (Max)
- Quiescent Current: 250μA per Amplifier (Typ)
- Input Common Mode Voltage Range Includes Ground

APPLICATION

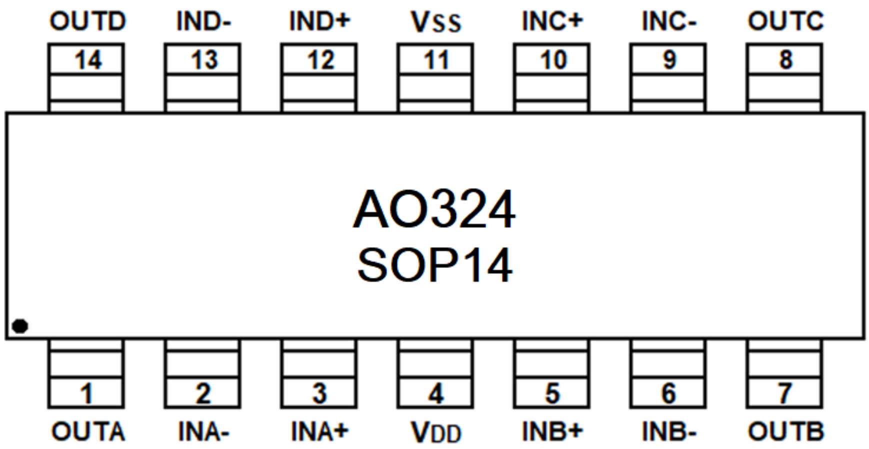
- Home Theaters, Chemical and Gas Sensors
- Digital Multimeter: Bench and Systems
- Field Transmitter: Temperature Sensors
- Motor Control: AC Induction, Brushed DC, Brushless DC, High-Voltage, Low-Voltage, Permanent Magnet, and Stepper Motor
- Oscilloscopes
- TV: LED and Digital
- Temperature Sensors and Controllers Using Modbus
- Weight Scales
- Walkie-Talkie, Multivibrators
- Battery Management Solution
- Transducer Amplifiers, Summing Amplifiers
- Portable Systems

TYPICAL APPLICATION



SOP14

PIN DESCRIPTION



SOP14, M14

Top View

Pin #	Symbol	Function
1	OUTA	Output A
2	INA-	Analog Inverting Input A
3	INA+	Analog Positive 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

Parameter	Symbol	Max
Power Supply Voltage	Vcc	±20V or 40V
Differential input voltage	$V_{I(DIFF)}$	40V
Input Voltage	V_I	-0.3V~40V
Operating Temperature Range	Topr	-25°C ~+85°C
Storage Temperature Range	Tstg	-65°C ~+150°C

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.

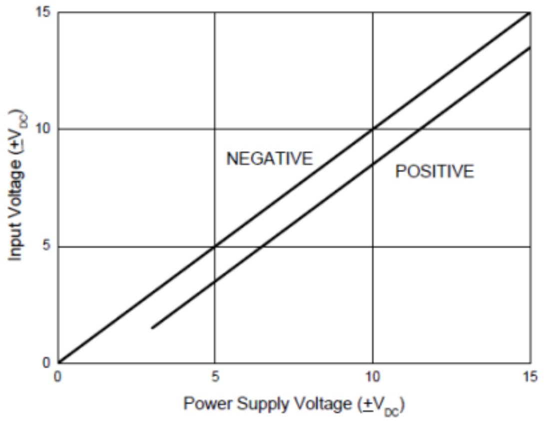
ELECTRICAL CHARACTERISTICS

V_S = +15V, T_A=25°C, unless otherwise noted.

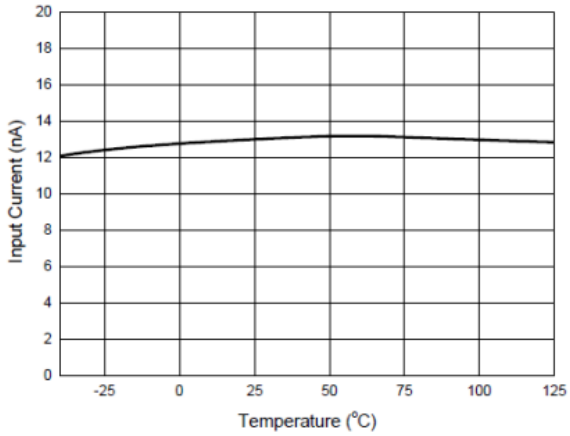
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Input Offset Voltage	V_{OS}	V_{CM} = V_S/2	-	0.4	5	mV
Input Bias Current	I_B		-	20	-	nA
Input Offset Current	I_{OS}		-	5	-	nA
Common-Mode Voltage Range	V_{CM}	V_S = 5.5V	-	-0.1 to +4	-	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = 0V to Vs-1.5V	60	70	-	dB
Open-Loop Voltage Gain	A_{OL}	R_L = 5kΩ, V_O = 1V to 11V	85	100	-	dB
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta_T$		-	7	-	μV/°C
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	V_{OH}	R_L = 2kΩ	-	11	-	V
	V_{OL}	R_L = 2kΩ	-	5	20	mV
	V_{OH}	R_L = 10kΩ	-	12	13	V
	V_{OL}	R_L = 10kΩ	-	5	20	mV
Output Current	I_{SOURCE}	R_L = 10Ω to V_S/2	-	40	60	mA
	I_{SINK}		-	40	60	
POWER SUPPLY						
Operating Voltage Range			3	-	-	V
			-	-	36	V
Power Supply Rejection Ratio	PSRR	V_S = +5V to +36V, V_{CM} = +0.5V	70	100	-	dB
Quiescent Current/Amplifier	I_Q	Vs=36V, R_L =∞	-	0.25	2.0	mA
DYNAMIC PERFORMANCE						
Gain-Bandwidth Product	GBP		-	1	-	MHz
Slew Rate	SR	G = +1, 2V Output Step	-	0.2	-	V/μs

TYPICAL PERFORMANCE CHARACTERISTICS

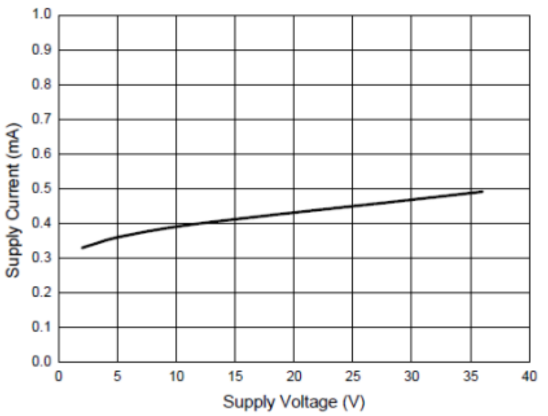
1. Input Voltage Range



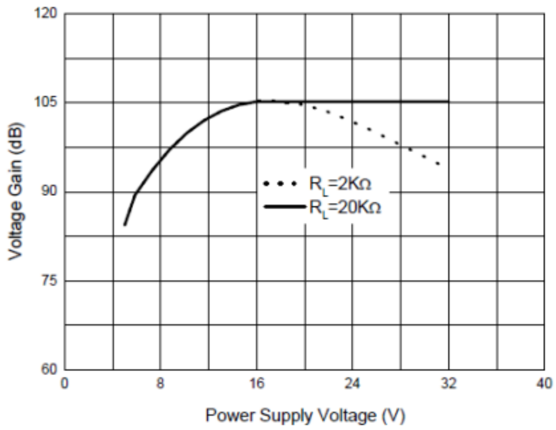
2. Input Current



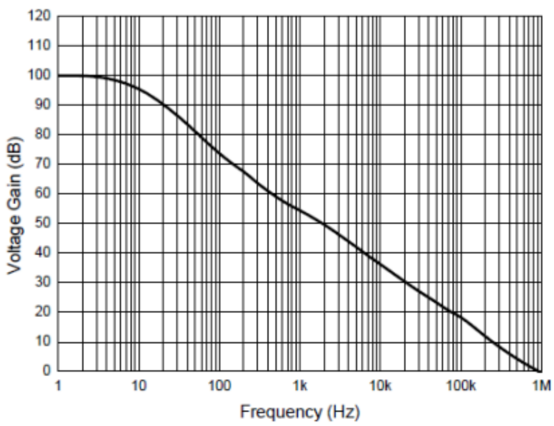
3. Supply Current



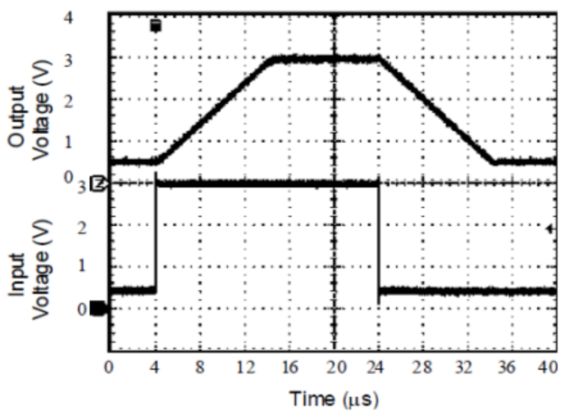
4. Voltage Gain



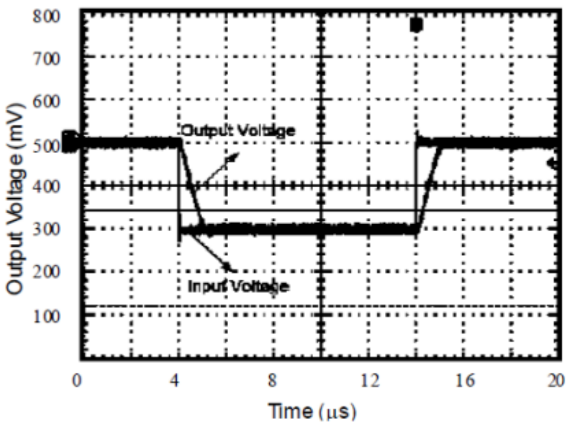
5. Open Loop Frequency Response



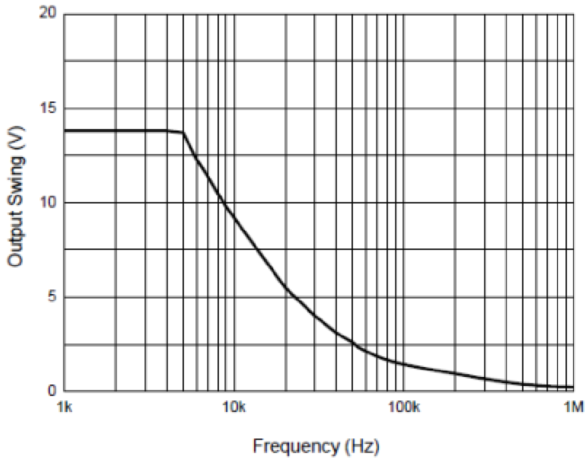
6. Voltage Follower Pulse Response



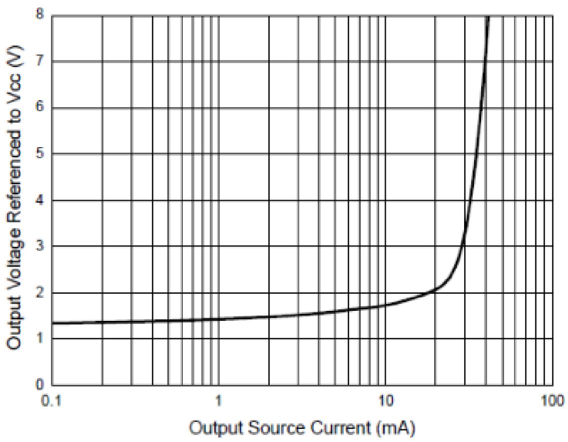
7. Voltage Follower Pulse Response(Small Signal)



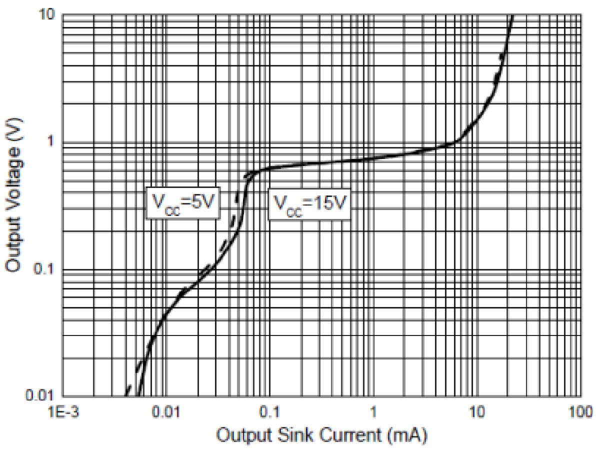
8. Large Signal Frequency Response



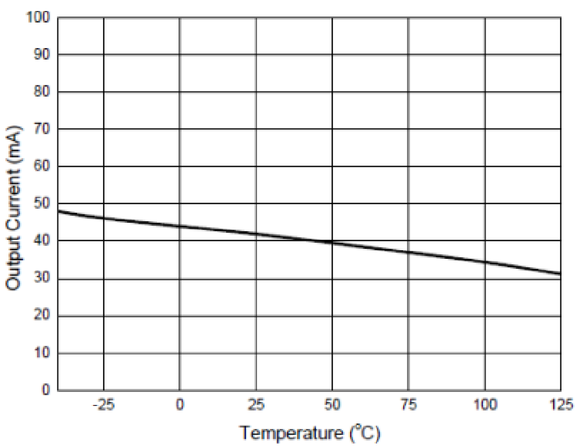
9. Output Characteristics :Current Sourcing



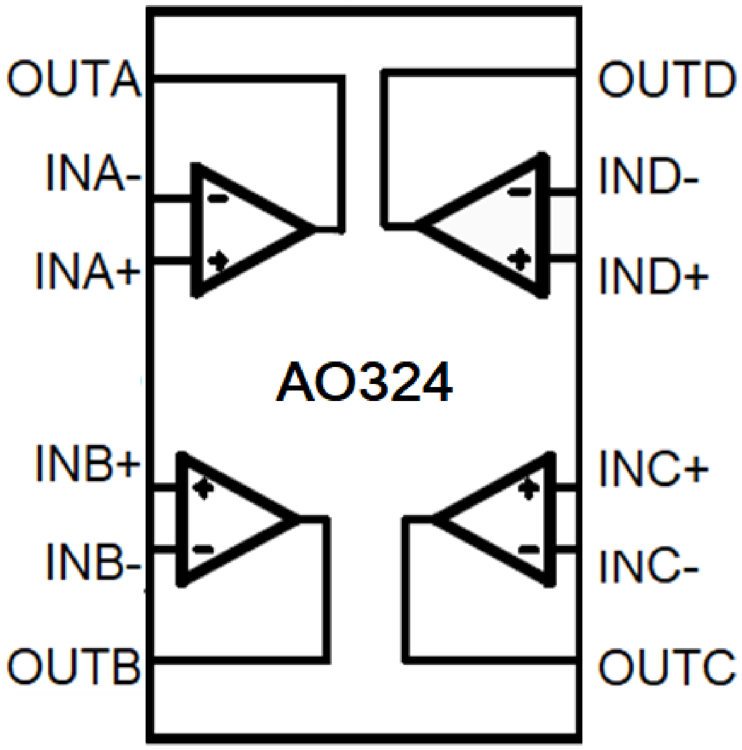
10. Output Characteristics : Current Sinking



11. Current Limiting



BLOCK DIAGRAM



DETAILED INFORMATION

AO324 op amp is unity-gain stable and suitable for a wide range of general-purpose applications.

Power Supply Bypassing and Board Layout

AO324 operates from a single 3V to 36V supply or dual ±1.5V to ±18V 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 250uA per channel) of AO324 will help to maximize battery life.

Operating Voltage

AO324 operates under wide input supply voltage (3V to 36V). In addition, all temperature specifications apply from -25℃ to +85℃. Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime.

Capacitive Load Tolerance

The AO324 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.

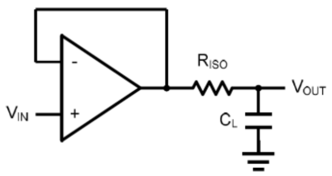


Figure 1. Indirectly Driving a Capacitive Load Using Isolation Resistor

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 $_{VIN}$ 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.

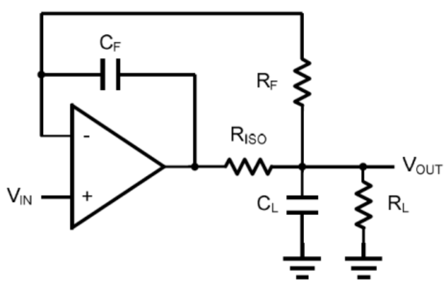


Figure 2. Indirectly Driving a Capacitive Load with DC Accuracy

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 AO324.

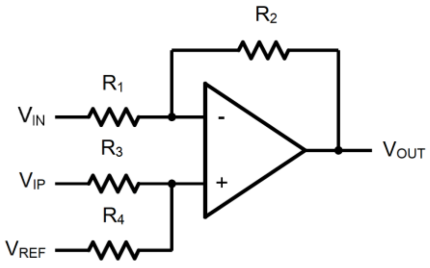


Figure 3. Differential Amplifier

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

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

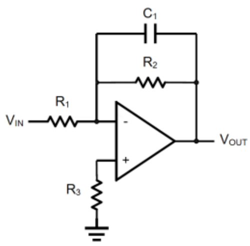


Figure 4. Low Pass Active Filter

Instrumentation Amplifier

The triple AO324 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.

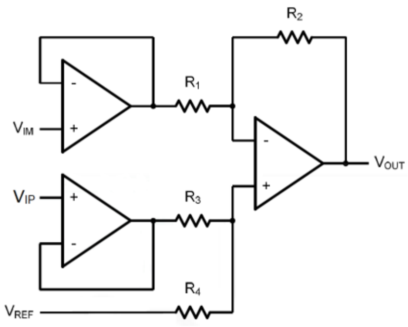
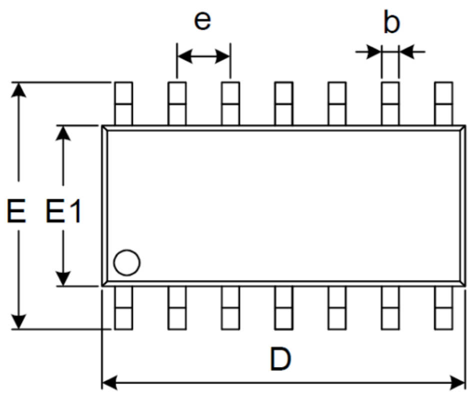
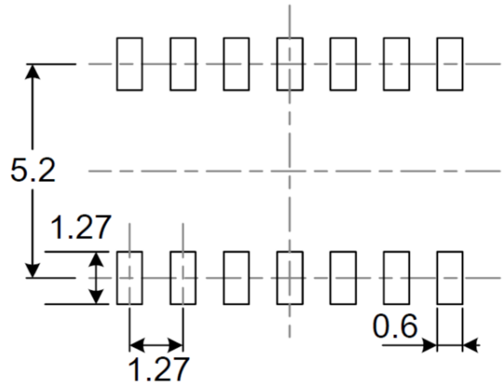


Figure 5. Instrument Amplifier

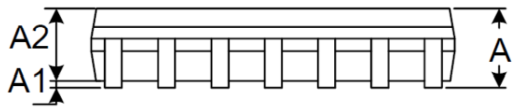
PACKAGE INFORMATION

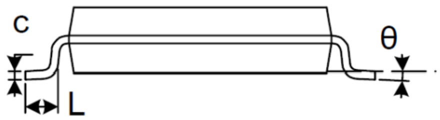
Dimension in SOP14 (Unit: mm)





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Millimeters	
	Min	Max
A	1.350	1.750
A1	0.100	0.250
A2	1.350	1.550
b	0.310	0.510
c	0.100	0.250
D	8.450	8.850
e	1.270 BSC	
E	5.800	6.200
E1	3.800	4.000
L	0.400	1.270
θ	0°	8°

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