

**LOW POWER QUAD OPERATIONAL AMPLIFIERS****AS324/324A****General Description**

The AS324/324A consist of four independent, high gain and internally frequency compensated operational amplifiers. They are specifically designed to operate from a single power supply. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. Typical applications include transducer amplifiers, DC gain blocks and most conventional operational amplifier circuits.

The AS324/324A series are compatible with industry standard 324. AS324A has more stringent input offset voltage than AS324.

The AS324 is available in SOIC-14, DIP-14 and TSSOP-14 packages, AS324A is available in SOIC-14 and DIP-14 packages.

**Features**

- Internally Frequency Compensated for Unity Gain
- Large Voltage Gain: 100dB (Typical)
- Low Input Bias Current: 20nA (Typical)
- Low Input Offset Voltage: 2mV (Typical)
- Low Supply Current: 0.5mA (Typical)
- Wide Power Supply Voltage Range:
  - Single Supply: 3V to 36V
  - Dual Supplies:  $\pm 1.5V$  to  $\pm 18V$
- Input Common Mode Voltage Range Includes Ground
- Large Output Voltage Swing: 0V to  $V_{CC} - 1.5V$
- Power Drain Suitable for Battery Operation

**Application**

- Battery Charger
- Cordless Telephone
- Switching Power Supply



Figure 1. Package Types of AS324/324A



**LOW POWER QUAD OPERATIONAL AMPLIFIERS**

**AS324/324A**

**Pin Configuration**

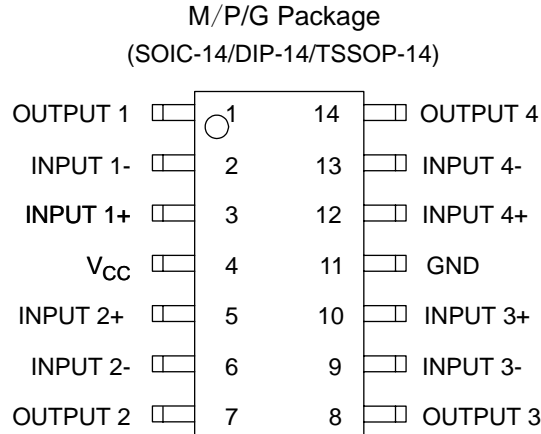


Figure 2. Pin Configuration of AS324/324A (Top View)

**Functional Block Diagram**

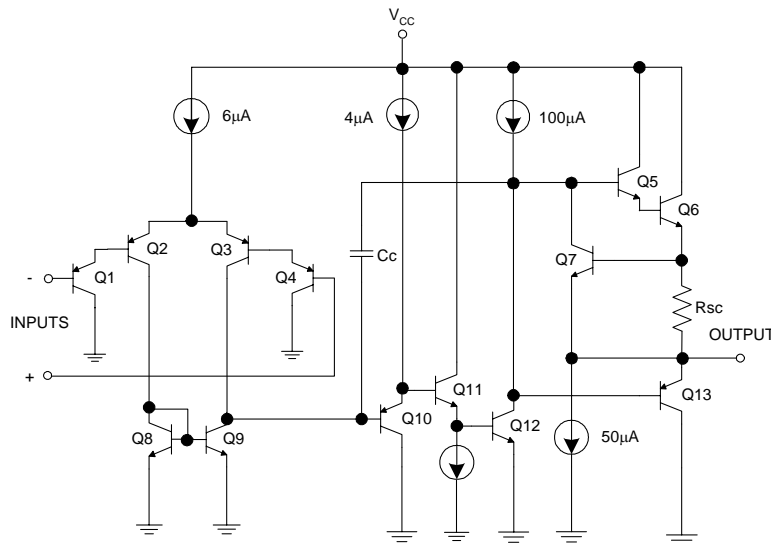
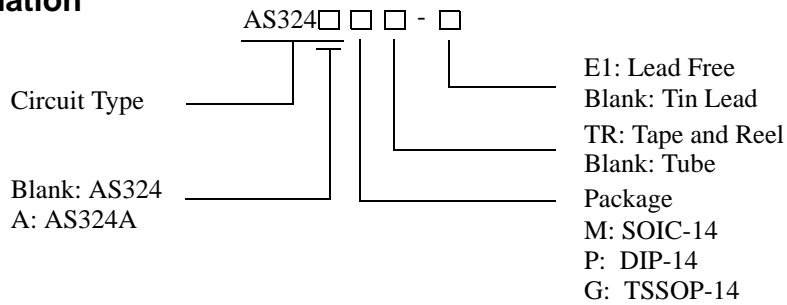


Figure 3. Functional Block Diagram of AS324/324A (Each Amplifier)

**Ordering Information**





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**AS324/324A**

**Ordering Information (Continuation)**

Package	Temperature Range	Part Number		Marking ID		Packing Type
		Tin Lead	Lead Free	Tin Lead	Lead Free	
SOIC-14	-40 to 85°C	AS324M	AS324M-E1	AS324M	AS324M-E1	Tube
		AS324MTR	AS324MTR-E1	AS324M	AS324M-E1	Tape & Reel
			AS324AM-E1		AS324AM-E1	Tube
			AS324AMTR-E1		AS324AM-E1	Tape & Reel
DIP-14		AS324P	AS324P-E1	AS324P	AS324P-E1	Tube
			AS324AP-E1		AS324AP-E1	Tube
TSSOP-14			AS324GTR-E1		EGS324	Tape & Reel
			AS324G-E1		EGS324	Tube

BCD Semiconductor's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant.

**Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Value		Unit
Supply Voltage	V <sub>CC</sub>	40		V
Differential Input Voltage	V <sub>ID</sub>	40		V
Input Voltage	V <sub>IN</sub>	-0.3 to 40		V
Total Power Dissipation (T <sub>A</sub> =25°C)	P <sub>D</sub>	DIP-14	1130	mW
		SOIC-14	800	
		TSSOP-14	710	
Operating Junction Temperature	T <sub>J</sub>	150		°C
Storage Temperature Range	T <sub>STG</sub>	-65 to 150		°C
Lead Temperature (Soldering, 10 Seconds)	T <sub>LEAD</sub>	260		°C

Note 1: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

**Recommended Operating Conditions**

Parameter	Symbol	Min	Max	Unit
Supply Voltage	V <sub>CC</sub>	3	36	V
Ambient Operating Temperature Range	T <sub>A</sub>	-40	85	°C



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**Electrical Characteristics**

Limits in standard typeface are for  $T_A=25^\circ\text{C}$ , **bold** typeface applies over  $T_A=-40^\circ\text{C}$  to  $85^\circ\text{C}$  (Note 2),  $V_{CC}=5\text{V}$ ,  $\text{GND}=0\text{V}$ , unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit	
Input Offset Voltage	$V_{IO}$	$V_O=1.4\text{V}$ , $R_S=0\ \Omega$ , $V_{CC}=5\text{V}$ to $30\text{V}$	AS324		2	5	mV
			AS324A		2	3	<b>7</b>
Average Temperature Coefficient of Input Offset Voltage	$\Delta V_{IO}/\Delta T$	$T_A=-40$ to $85^\circ\text{C}$		7		$\mu\text{V}/^\circ\text{C}$	
Input Offset Current	$I_{IO}$	$I_{IN^+} - I_{IN^-}$ , $V_{CM}=0\text{V}$		5	30	nA	
Input Bias Current	$I_{BIAS}$	$I_{IN^+}$ or $I_{IN^-}$ , $V_{CM}=0\text{V}$		20	100	nA	
Input Common Mode Voltage Range (Note 3)	$V_{IR}$	$V_{CC}=30\text{V}$	0		$V_{CC}-1.5$	V	
Supply Current	$I_{CC}$	$T_A=-40$ to $85^\circ\text{C}$ , $R_L=\infty$	$V_{CC}=30\text{V}$		1.0	3	mA
			$V_{CC}=5\text{V}$		0.7	1.2	
Large Signal Voltage Gain	$G_V$	$V_{CC}=15\text{V}$ , $R_L \geq 2\text{k}\Omega$ , $V_O=1\text{V}$ to $11\text{V}$	85	100		dB	
			<b>80</b>				
Common Mode Rejection Ratio	CMRR	DC, $V_{CM}=0$ to $(V_{CC}-1.5)\text{V}$	60	70		dB	
			<b>60</b>				
Power Supply Rejection Ratio	PSRR	$V_{CC}=5$ to $30\text{V}$	70	100		dB	
			<b>60</b>				
Channel Separation	CS	$f=1\text{kHz}$ to $20\text{kHz}$		-120		dB	
Output Current	Source	$I_{SOURCE}$	$V_{IN^+}=1\text{V}$ , $V_{IN^-}=0\text{V}$ , $V_{CC}=15\text{V}$ , $V_O=2\text{V}$	20	40		mA
	Sink	$I_{SINK}$	$V_{IN^+}=0\text{V}$ , $V_{IN^-}=1\text{V}$ , $V_{CC}=15\text{V}$ , $V_O=2\text{V}$	10	15		
			$V_{IN^+}=0\text{V}$ , $V_{IN^-}=1\text{V}$ , $V_{CC}=15\text{V}$ , $V_O=0.2\text{V}$	12	50		$\mu\text{A}$
Output Short Circuit Current to Ground	$I_{SC}$	$V_{CC}=15\text{V}$		40	60	mA	
Output Voltage Swing	$V_{OH}$	$V_{CC}=30\text{V}$ , $R_L=2\text{k}\Omega$	26			V	
			<b>26</b>				
		$V_{CC}=30\text{V}$ , $R_L=10\text{k}\Omega$	27	28			
			<b>27</b>				
$V_{OL}$	$V_{CC}=5\text{V}$ , $R_L=10\text{k}\Omega$		5	20	mV		
				<b>30</b>			

Note 2: Limits over the full temperature are guaranteed by design, but not tested in production.



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**Electrical Characteristics (Continued)**

Note 3: The input common-mode voltage of either input signal voltage should not be allowed to go negatively by more than 0.3V (at 25°C). The upper end of the common-mode voltage range is  $V_{CC} - 1.5V$  (at 25°C), but either or both inputs can go to +36V without damages, independent of the magnitude of the  $V_{CC}$ .

**Typical Performance Characteristics**

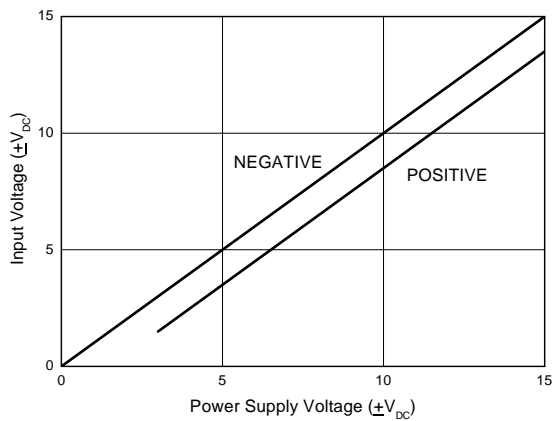


Figure 4. Input Voltage Range

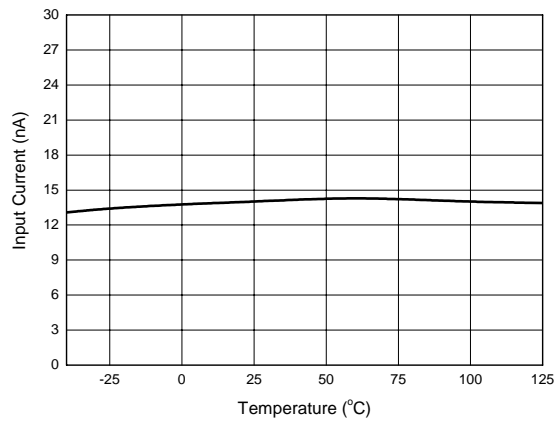


Figure 5. Input Current

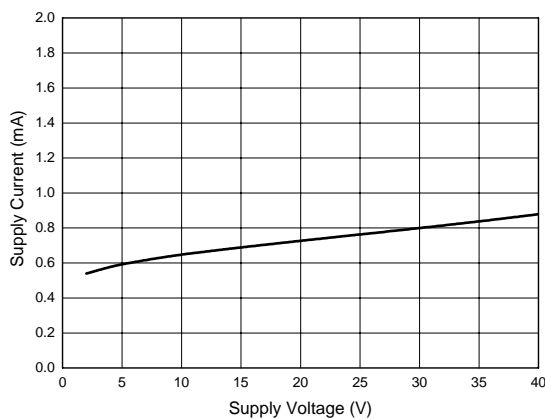


Figure 6. Supply Current

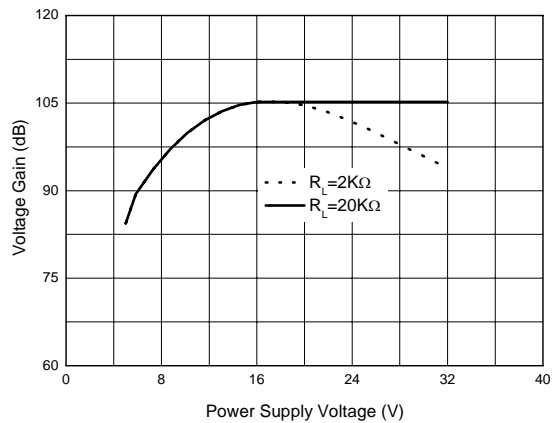


Figure 7. Voltage Gain



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**Typical Performance Characteristics (Continued)**

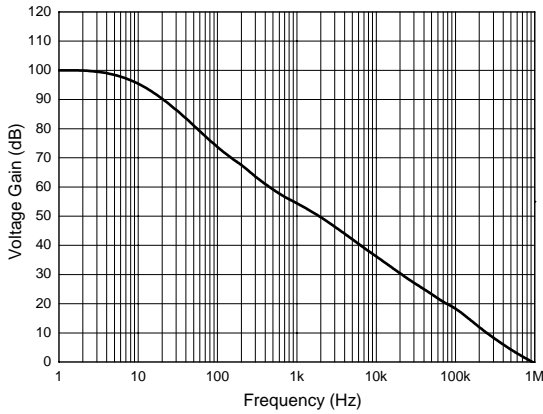


Figure 8. Open Loop Frequency Response

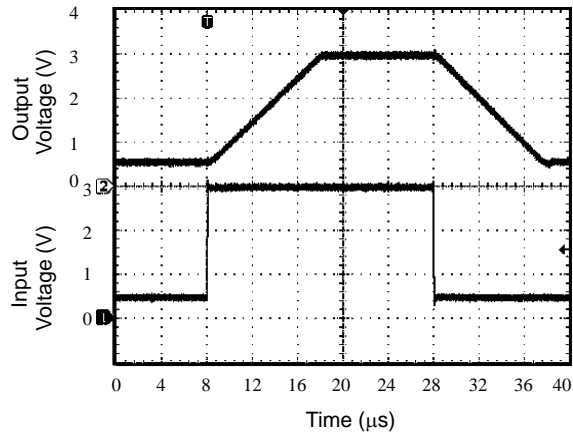


Figure 9. Voltage Follower Pulse Response

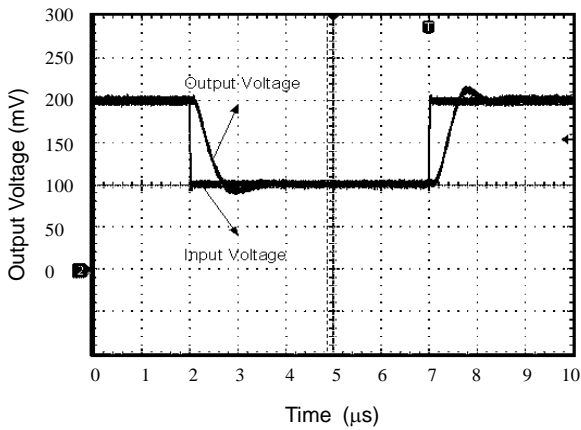


Figure 10. Voltage Follower Pulse Response (Small Signal)

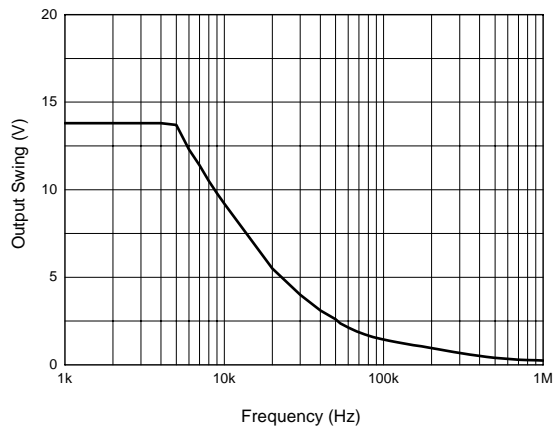


Figure 11. Large Signal Frequency Response



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**Typical Performance Characteristics (Continued)**

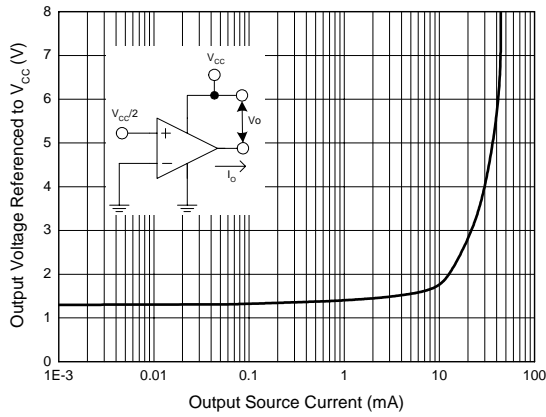


Figure 12. Output Characteristics: Current Sourcing

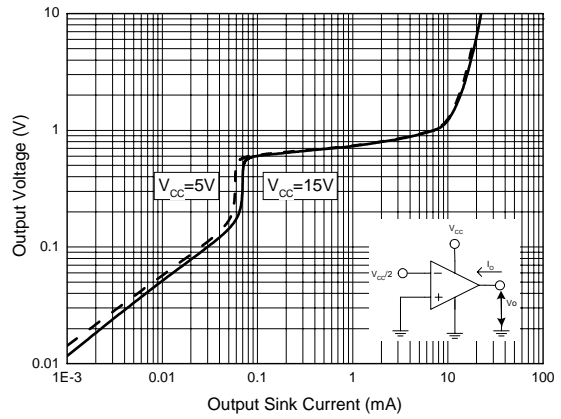


Figure 13. Output Characteristics: Current Sinking

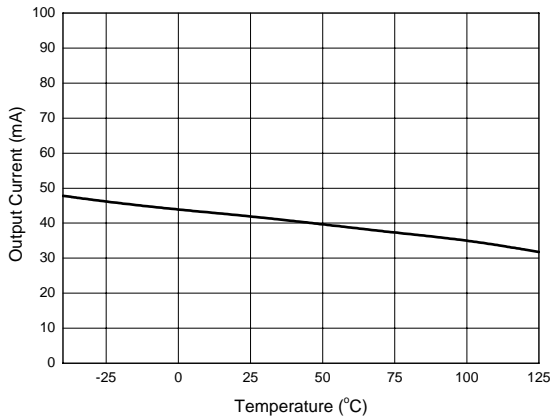


Figure 14. Current Limiting



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**Typical Applications**

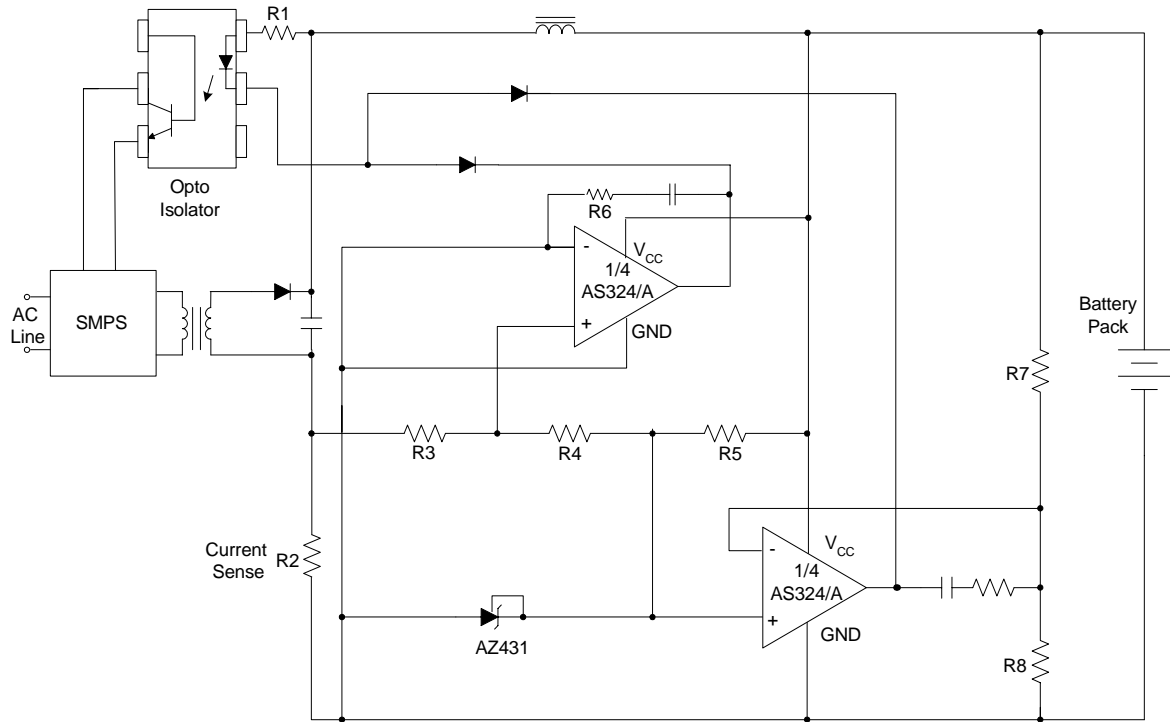


Figure 15. Battery Charger

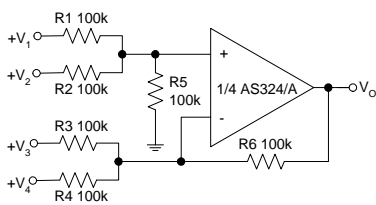


Figure 16. DC Summing Amplifier

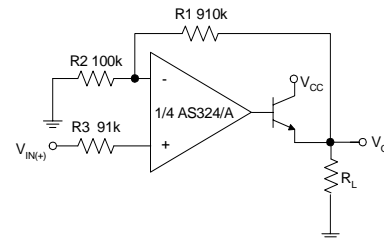


Figure 17. Power Amplifier





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**Typical Applications (Continued)**

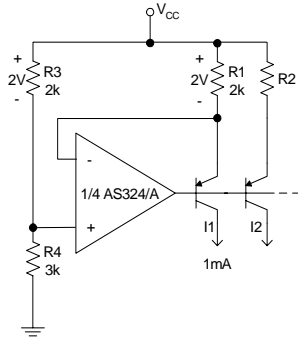


Figure 18. Fixed Current Sources

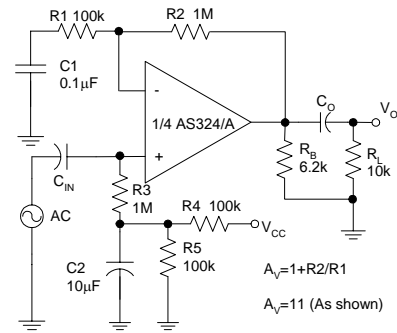


Figure 19. AC Coupled Non-Inverting Amplifier

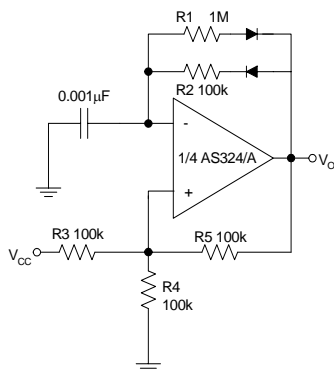


Figure 20. Pulse Generator

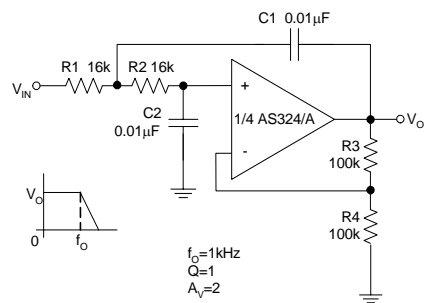


Figure 21. DC Coupled Low-Pass RC Active Filter



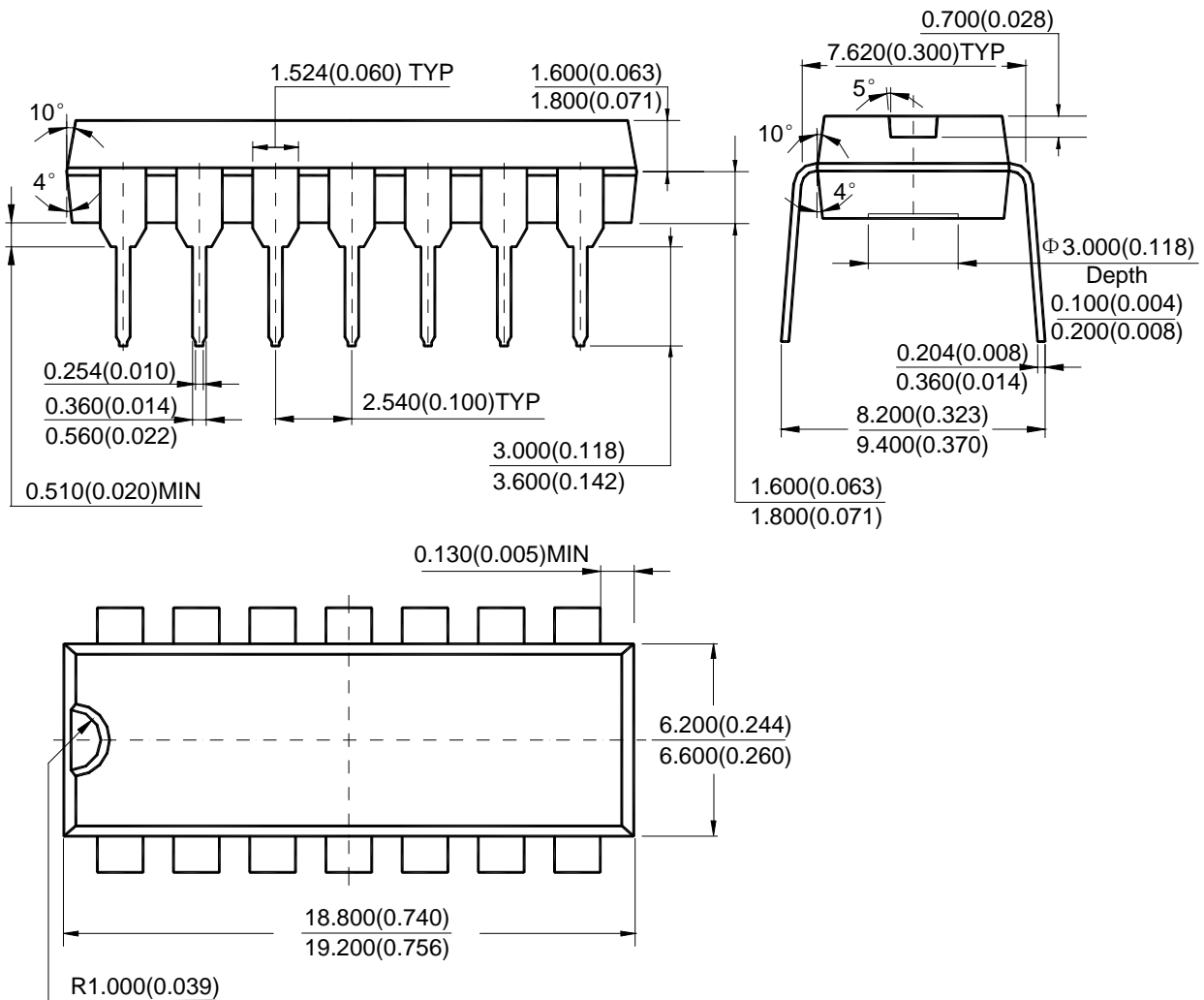
**LOW POWER QUAD OPERATIONAL AMPLIFIERS**

**AS324/324A**

**Mechanical Dimension**

**DIP-14**

**Unit: mm(inch)**





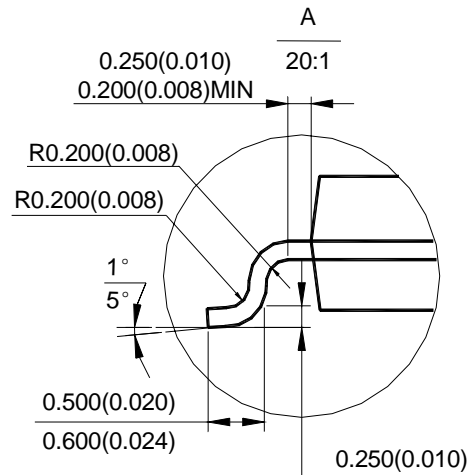
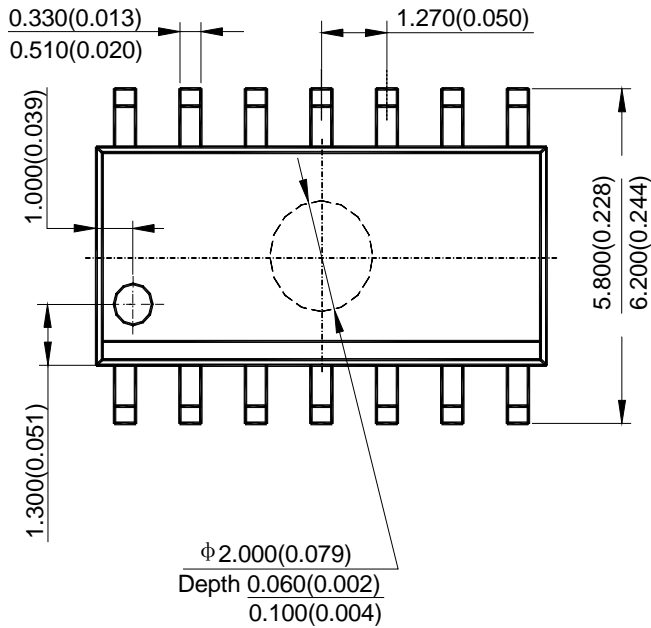
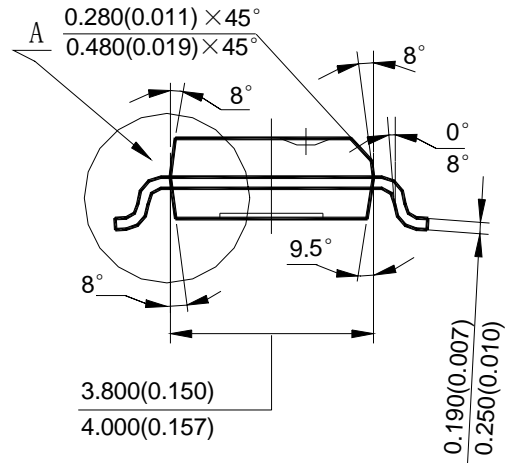
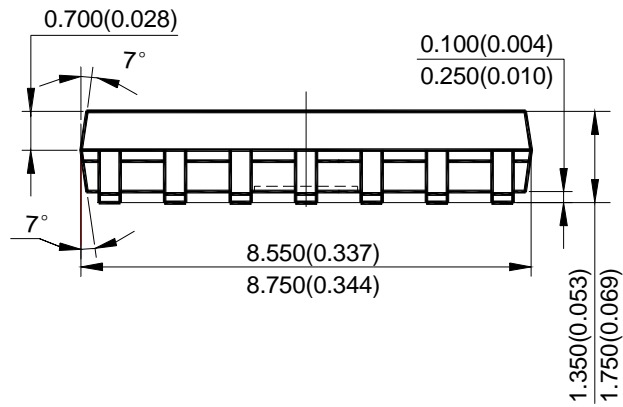
**LOW POWER QUAD OPERATIONAL AMPLIFIERS**

**AS324/324A**

**Mechanical Dimension (Continued)**

**SOIC-14**

**Unit: mm(inch)**







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