



**THE DATASHEET OF  
AS324AMTR-E1**



## 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. The AS324A has more stringent input offset voltage than AS324.

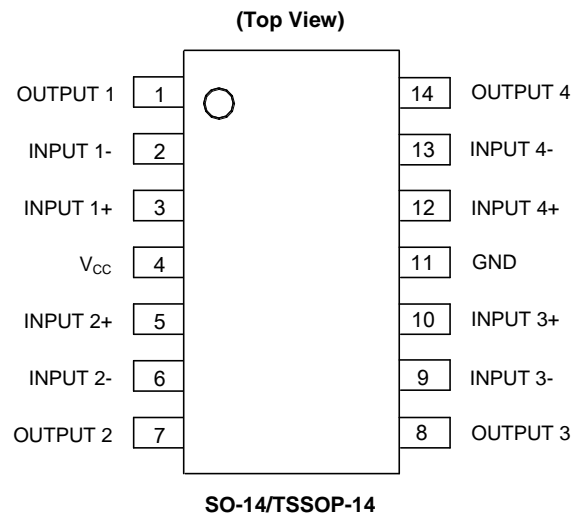
The AS324 is available in SO-14 and TSSOP-14 packages, and the AS324A is available in SO-14 package.

## 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
- Lead-Free Packages: SO-14, TSSOP-14
  - **Totally Lead-Free; RoHS Compliant (Notes 1 & 2)**
- Lead-Free Packages, Available in "Green" Molding Compound: SO-14, TSSOP-14
  - **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
  - **Halogen and Antimony Free. "Green" Device (Note 3)**

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
  2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
  3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

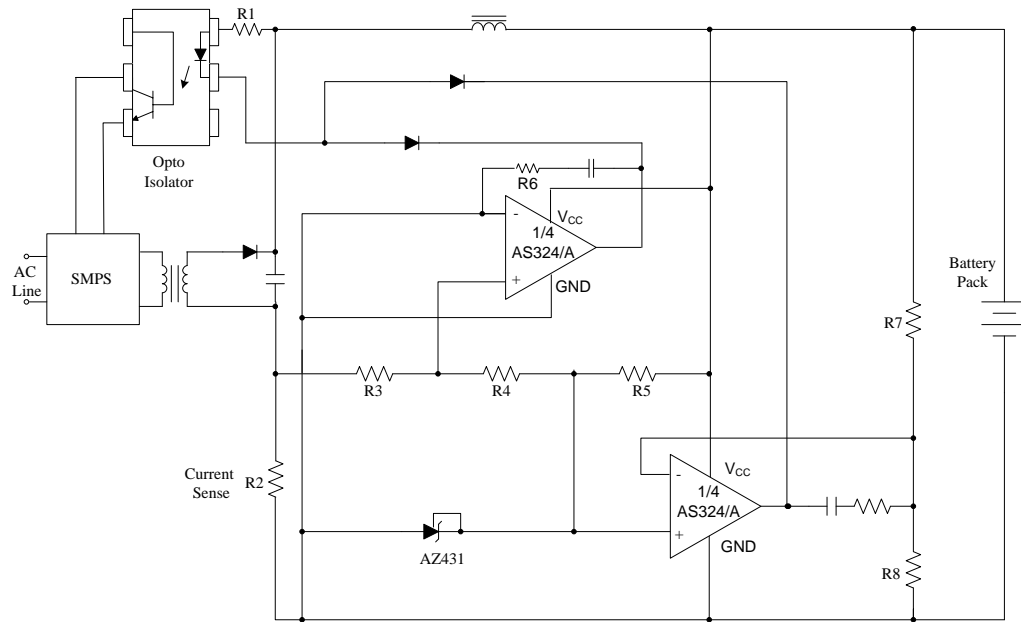
## Pin Assignments



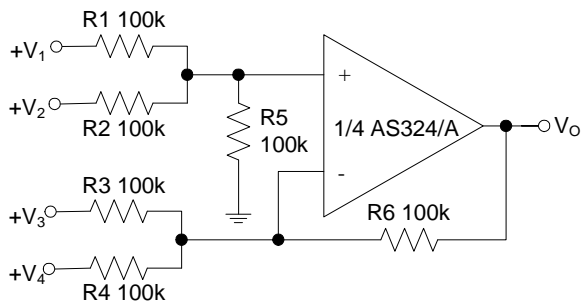
## Applications

- Battery Charger
- Cordless Telephone
- Switching Power Supply

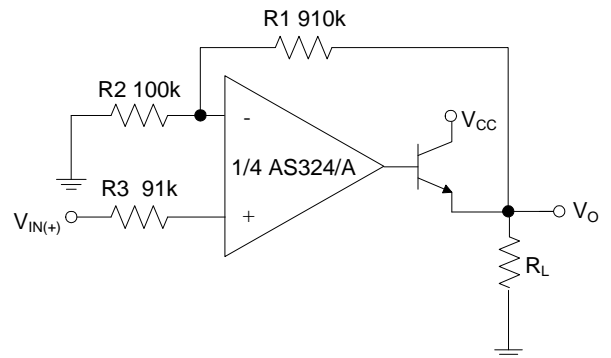
**Typical Applications Circuit**



**Battery Charger**

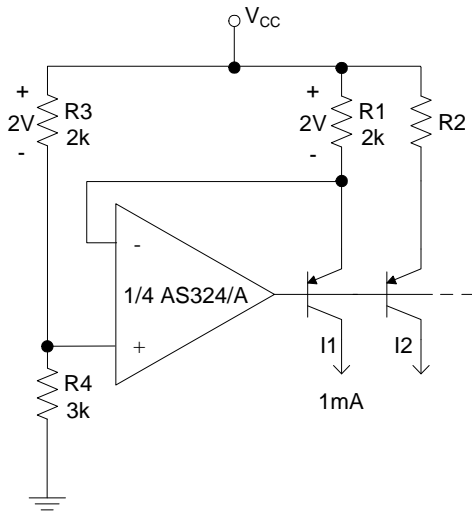


**DC Summing Amplifier**

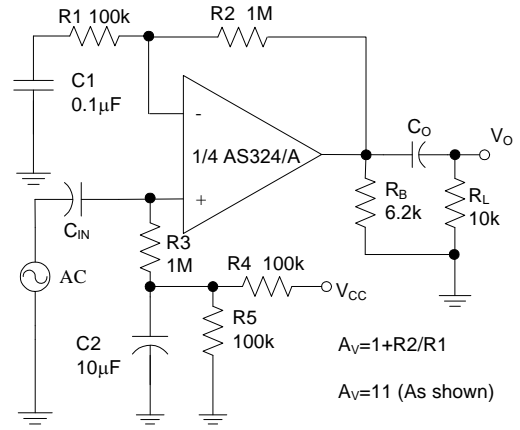


**Power Amplifier**

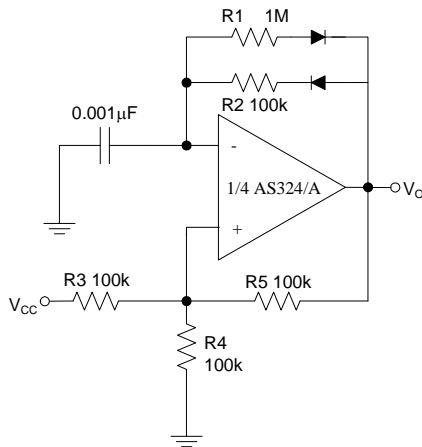
**Typical Applications Circuit** (continued)



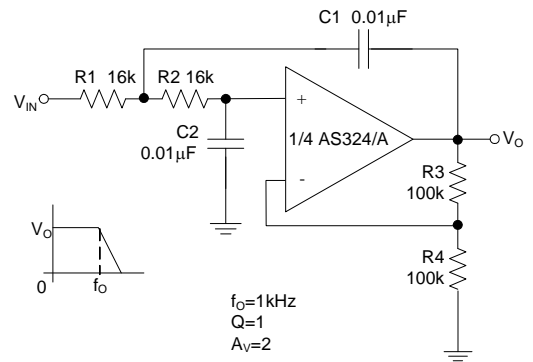
Fixed Current Sources



AC Coupled Non-Inverting Amplifier

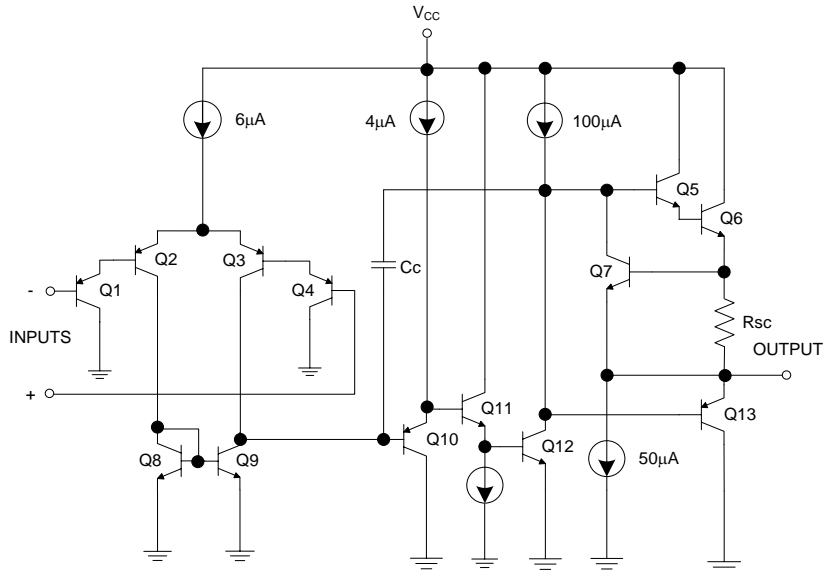


Pulse Generator



DC Coupled Low-Pass RC Active Filter

**Functional Block Diagram**



**Absolute Maximum Ratings** (Note 4)

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

Note 4: 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**

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

**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 5),  $V_{CC} = 5\text{V}$ ,  $\text{GND} = 0\text{V}$ , unless otherwise specified.)

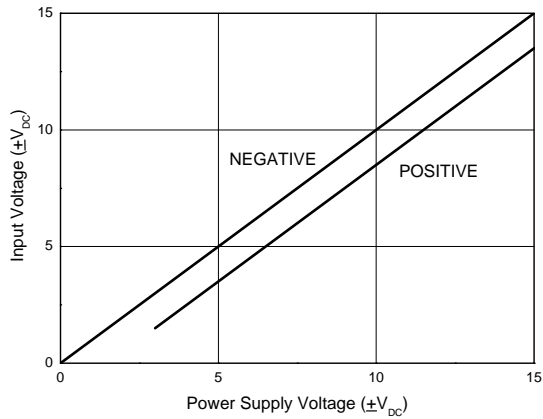
Symbol	Parameter		Conditions	Min	Typ	Max	Unit	
$V_{IO}$	Input Offset Voltage		$V_O = 1.4\text{V}$ , $R_S = 0\Omega$ , $V_{CC} = 5\text{V}$ to $30\text{V}$	AS324	—	2	5	mV
					—	—	<b>7</b>	
				AS324A	—	2	3	mV
					—	—	<b>5</b>	
$\Delta V_{IO}/\Delta T$	Average Temperature Coefficient of Input Offset Voltage		$T_A = -40$ to $+85^\circ\text{C}$	—	7	—	$\mu\text{V}/^\circ\text{C}$	
$I_{IO}$	Input Offset Current		$I_{IN+} - I_{IN-}$ , $V_{CM} = 0\text{V}$	—	5	30	nA	
				—	—	<b>100</b>		
$I_{BIAS}$	Input Bias Current		$I_{IN+}$ or $I_{IN-}$ , $V_{CM} = 0\text{V}$	—	20	100	nA	
				—	—	<b>200</b>		
$V_{IR}$	Input Common Mode Voltage Range (Note 6)		$V_{CC} = 30\text{V}$	0	—	$V_{CC} - 1.5$	V	
$I_{CC}$	Supply Current		$T_A = -40$ 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	
$G_V$	Large Signal Voltage Gain		$V_{CC} = 15\text{V}$ , $R_L \geq 2\text{k}\Omega$ , $V_O = 1\text{V}$ to $11\text{V}$	85	100	—	dB	
				<b>80</b>	—	—		
CMRR	Common Mode Rejection Ratio		DC, $V_{CM} = 0$ to $(V_{CC} - 1.5)\text{V}$	60	70	—	dB	
				<b>60</b>	—	—		
PSRR	Power Supply Rejection Ratio		$V_{CC} = 5$ to $30\text{V}$	70	100	—	dB	
				<b>60</b>	—	—		
CS	Channel Separation		$f = 1\text{kHz}$ to $20\text{kHz}$	—	-120	—	dB	
$I_{SOURCE}$	Output Current	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		20	—	—		
$I_{SINK}$	Sink		$V_{IN+} = 0\text{V}$ , $V_{IN-} = 1\text{V}$ , $V_{CC} = 15\text{V}$ , $V_O = 2\text{V}$	10	15	—	mA	
				<b>5</b>	—	—		
$I_{SC}$	Output Short Circuit Current to Ground		$V_{CC} = 15\text{V}$	12	50	—	$\mu\text{A}$	
				<b>5</b>	—	—		
$V_{OH}$	Output Voltage Swing		$V_{CC} = 30\text{V}$ , $R_L = 2\text{k}\Omega$	—	40	60	mA	
				—	40	60		
$V_{OL}$				$V_{CC} = 30\text{V}$ , $R_L = 10\text{k}\Omega$	26	—	—	V
					<b>26</b>	—	—	
$V_{OL}$	$V_{CC} = 5\text{V}$ , $R_L = 10\text{k}\Omega$	27	28	—	mV			
		<b>27</b>	—	—				
$\theta_{JC}$	Thermal Resistance (Junction to Case)	SO-14	—	18	—	$^\circ\text{C}/\text{W}$		
		TSSOP-14	—	20	—			
$\theta_{JA}$	Thermal Resistance (Junction to Ambient)	SO-14	—	91	—	$^\circ\text{C}/\text{W}$		
		TSSOP-14	—	133	—			

Notes: 5. Limits over the full temperature are guaranteed by design, but not tested in production.

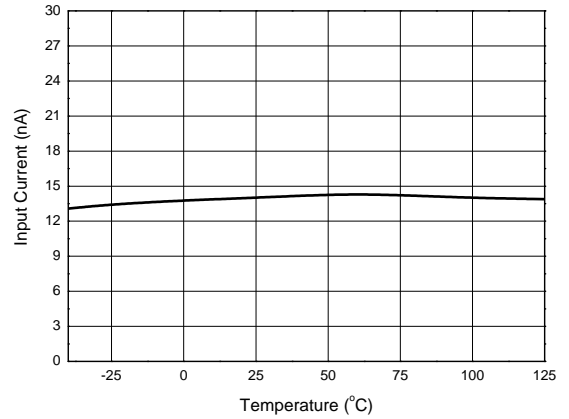
6. The input common-mode voltage of either input signal voltage should not be allowed to go negatively by more than 0.3V (at  $+25^\circ\text{C}$ ). The upper end of the common-mode voltage range is  $V_{CC} - 1.5\text{V}$  (at  $+25^\circ\text{C}$ ), but either or both inputs can go to  $+36\text{V}$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

**Performance Characteristics**

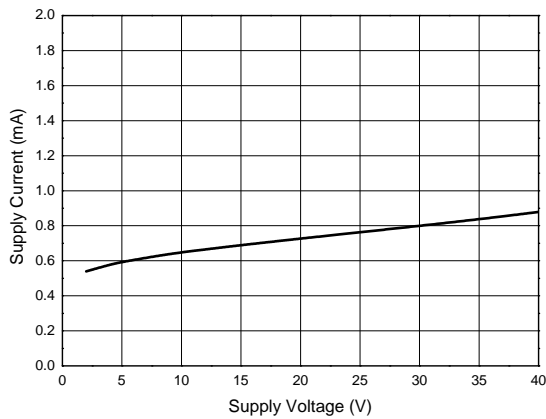
**Input Voltage Range**



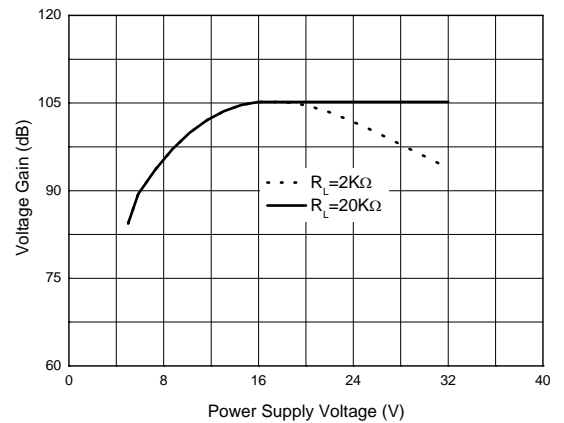
**Input Current**



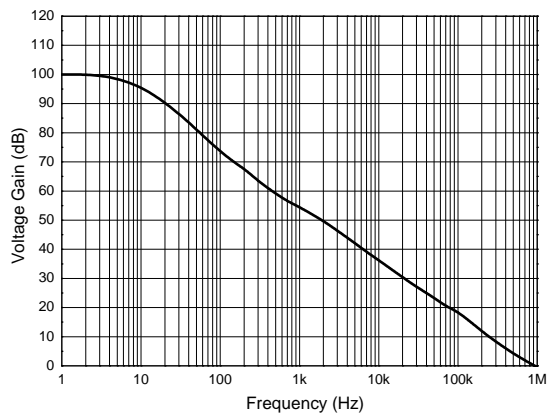
**Supply Current**



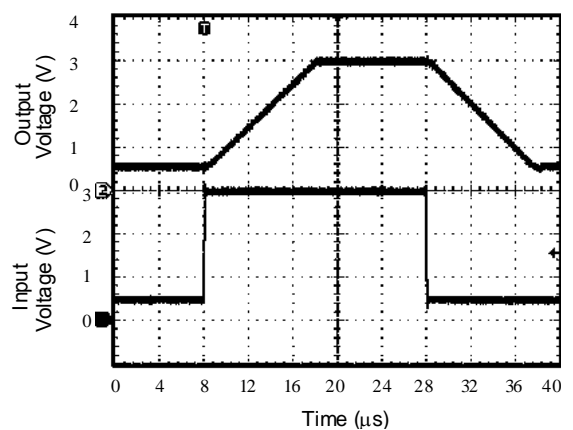
**Voltage Gain**



**Open Loop Frequency Response**

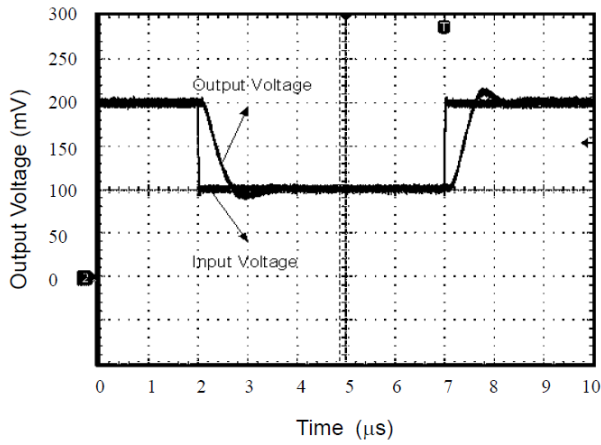


**Voltage Follower Pulse Response**

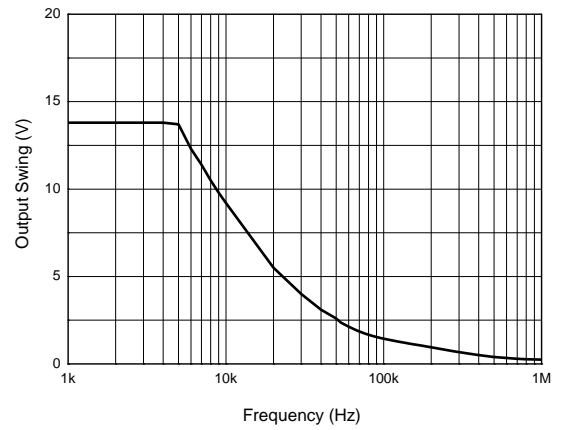


**Performance Characteristics** (continued)

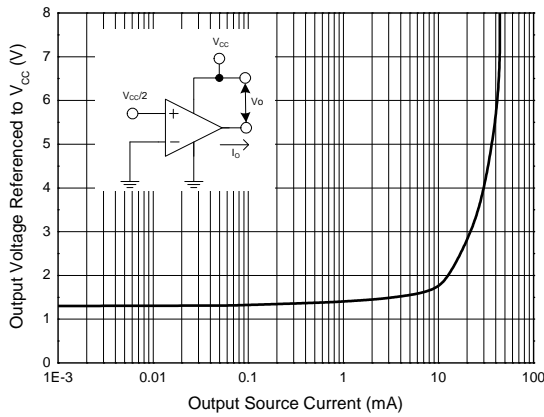
**Voltage Follower Pulse Response (Small Signal)**



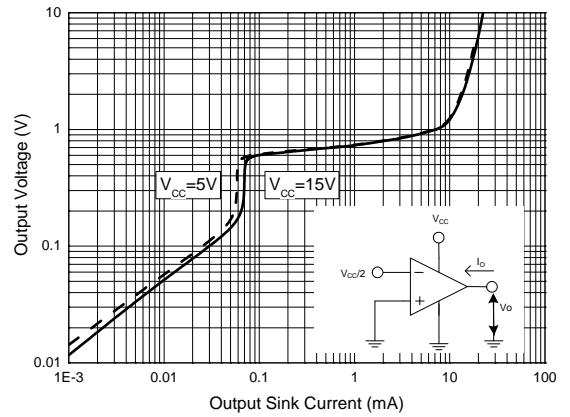
**Large Signal Frequency Response**



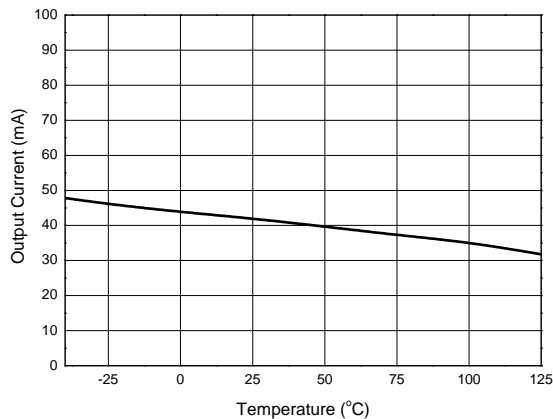
**Output Characteristics: Current Sourcing**



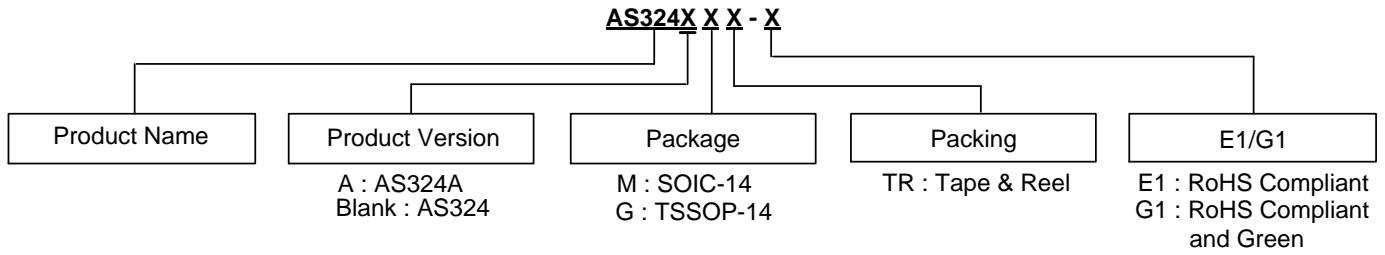
**Output Characteristics: Current Sinking**













**Current Limiting**



## Ordering Information

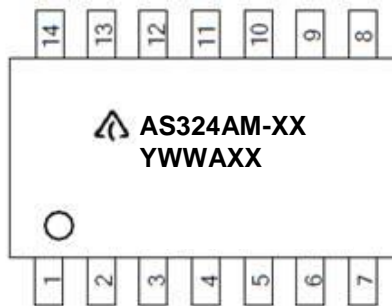
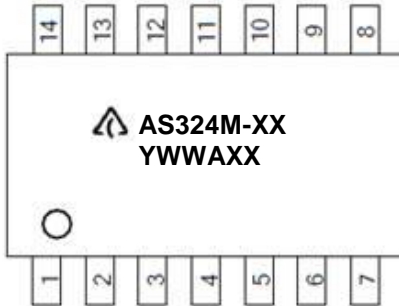


Part Number	Package (Note 8)	RoHS Compliant Lead Free / Green	Marking ID	Packing	Quantity	Status (Note 7)	Alternative
 AS324M-E1	SO-14	Lead Free	AS324M-E1	Tube	NA	End of Life	AS324MTR-G1
 AS324MTR-E1	SO-14	Lead Free	AS324M-E1	Tape & Reel	4000	NRND	AS324MTR-G1
 AS324AM-E1	SO-14	Lead Free	AS324AM-E1	Tube	NA	End of Life	AS324AMTR-G1
 AS324AMTR-E1	SO-14	Lead Free	AS324AM-E1	Tape & Reel	4000	NRND	AS324MTR-G1
 AS324M-G1	SO-14	Green	AS324M-G1	Tube	NA	End of Life	AS324AMTR-G1
 AS324MTR-G1	SO-14	Green	AS324M-G1	Tape & Reel	4000	In Production	—
 AS324AM-G1	SO-14	Green	AS324AM-G1	Tube	NA	End of Life	AS324AMTR-G1
 AS324AMTR-G1	SO-14	Green	AS324AM-G1	Tape & Reel	4000	In Production	—
 AS324GTR-E1	TSSOP-14	Lead Free	EGS324	Tape & Reel	4000	NRND	AS324GTR-G1
 AS324GTR-G1	TSSOP-14	Green	GG324	Tape & Reel	4000	In Production	—

- Notes:
- 7. All variants in Tube packing with package SO-14 are End of Life.  
All variants with package DIP-14 are End of Life without replacements.  
NRND: Not Recommended for New Design.
  - 8. For packaging details, go to our website at: <https://www.diodes.com/design/support/packaging/diodes-packaging/>.

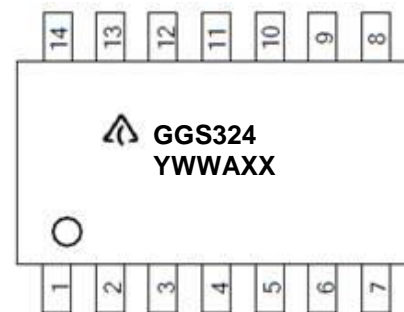
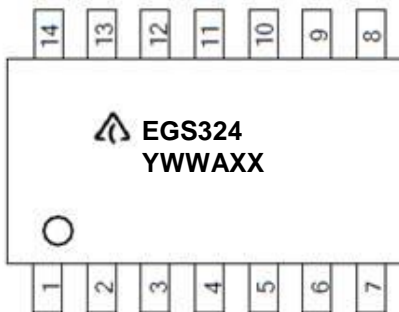
**Marking information**

(1) SO-14



First Line: Logo and Marking ID  
(See Ordering Information)  
Second Line: Date Code  
Y: Year  
WW: Work Week of Molding  
A: Assembly House Code  
XX: 7<sup>th</sup> and 8<sup>th</sup> Digits of Batch Number

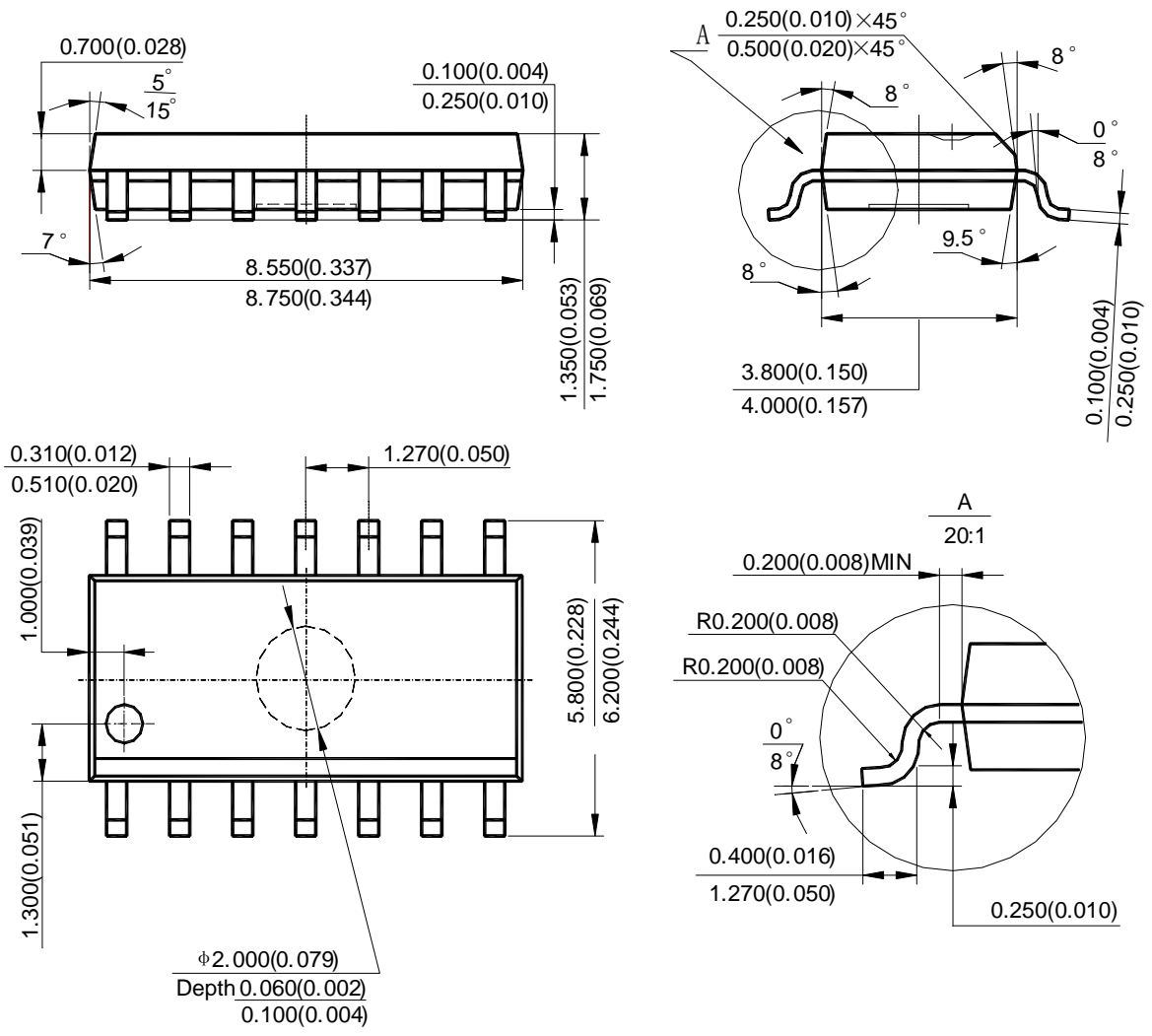
(2) TSSOP14



First Line: Logo and Marking ID  
(See Ordering Information)  
Second Line: Date Code  
Y: Year  
WW: Work Week of Molding  
A: Assembly House Code  
XX: 7<sup>th</sup> and 8<sup>th</sup> Digits of Batch Number

**Package Outline Dimensions** (All dimensions in mm (inch).)

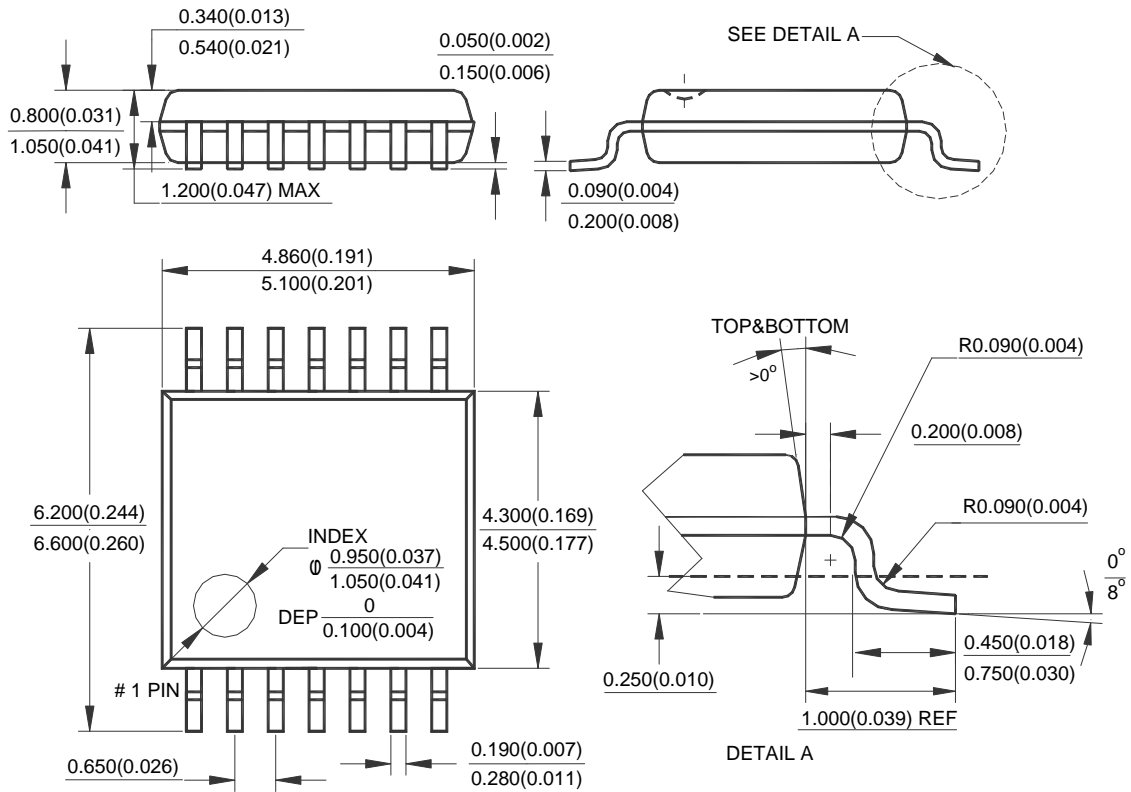
(1) Package Type: SO-14



Note: Eject hole, oriented hole and mold mark is optional.

**Package Outline Dimensions** (continued) (All dimensions in mm(inch).)

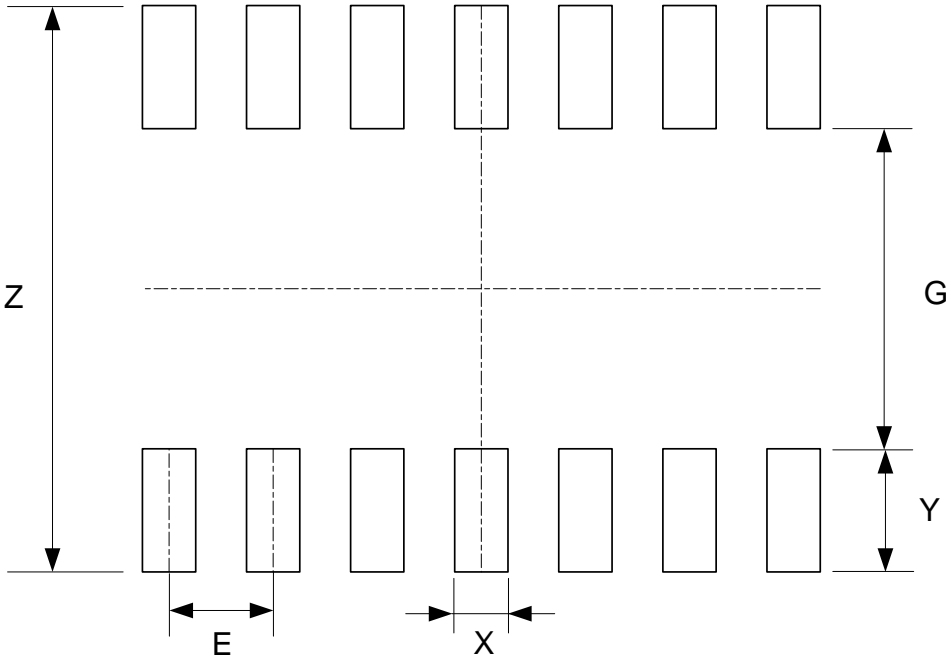
(2) Package Type: TSSOP-14



Note: Eject hole, oriented hole and mold mark is optional.

**Suggested Pad Layout**

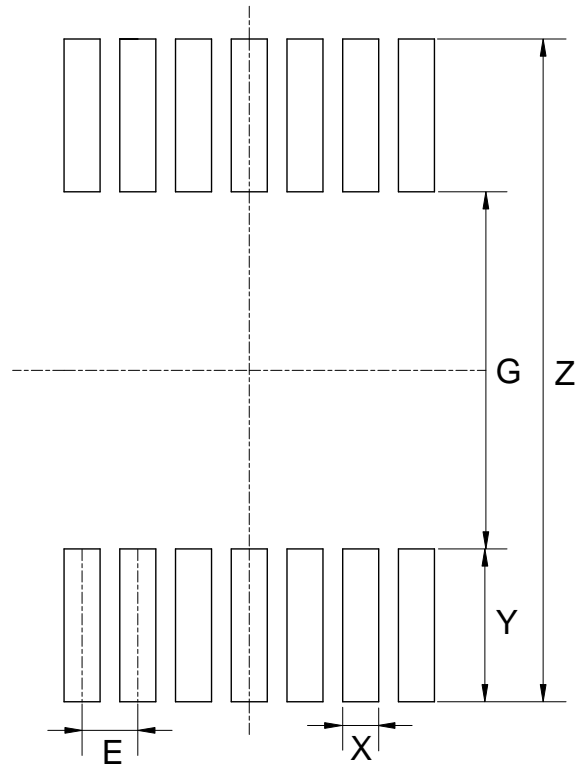
(1) Package Type: SO-14



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
Value	6.900/0.272	3.900/0.154	0.650/0.026	1.500/0.059	1.270/0.050

**Suggested Pad Layout** (continued)

(2) Package Type: TSSOP-14



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
Value	7.720/0.304	4.160/0.164	0.420/0.017	1.780/0.070	0.650/0.026

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