LM324, LM324A, LM224, LM2902, LM2902V, NCV2902

Single Supply Quad Operational Amplifiers

The LM324 series are low−cost, quad operational amplifiers with true differential inputs. They have several distinct advantages over standard operational amplifier types in single supply applications. The quad amplifier can operate at supply voltages as low as 3.0 V or as high as 32 V with quiescent currents about one−fifth of those associated with the MC1741 (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.

Features

- Pb−Free Packages are Available*
- Short Circuited Protected Outputs
- True Differential Input Stage
- Single Supply Operation: 3.0 V to 32 V
- Low Input Bias Currents: 100 nA Maximum (LM324A)
- Four Amplifiers Per Package
- Internally Compensated
- Common Mode Range Extends to Negative Supply
- Industry Standard Pinouts
- ESD Clamps on the Inputs Increase Ruggedness without Affecting Device Operation
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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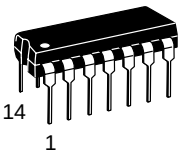
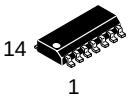
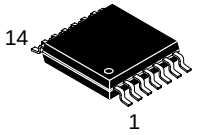


PDIP−14
N SUFFIX
CASE 646



SOIC−14
D SUFFIX
CASE 751A



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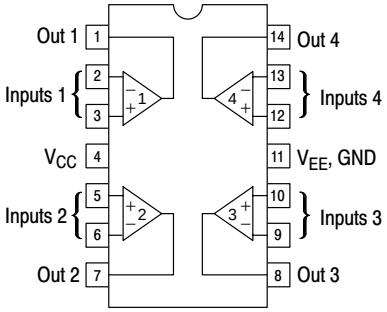
PIN CONNECTIONS



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 10 of this data sheet.

MAXIMUM RATINGS (T_A = +25°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Power Supply Voltages Single Supply Split Supplies	 V_{CC} V_{CC}, V_{EE}	 32 ±16	Vdc
Input Differential Voltage Range (Note 1)	V_{IDR}	±32	Vdc
Input Common Mode Voltage Range	V_{ICR}	−0.3 to 32	Vdc
Output Short Circuit Duration	t_{SC}	Continuous	
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
ESD Protection at any Pin Human Body Model Machine Model	V_{esd}	 2000 200	V
Operating Ambient Temperature Range LM224 LM324, 324A LM2902 LM2902V, NCV2902	T_A	 −25 to +85 0 to +70 −40 to +105 −40 to +125	°C

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. Split Power Supplies.

ELECTRICAL CHARACTERISTICS (V_{CC} = 5.0 V, V_{EE} = GND, T_A = 25°C, unless otherwise noted.)

Characteristics	Symbol	LM224			LM324A			LM324			LM2902			LM2902V/NCV2902			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage V_{CC} = 5.0 V to 30 V V_{ICR} = 0 V to V_{CC} −1.7 V, V_O = 1.4 V, R_S = 0 Ω	V_{IO}																mV
T_A = 25°C		−	2.0	5.0	−	2.0	3.0	−	2.0	7.0	−	2.0	7.0	−	2.0	7.0	
T_A = T_{high} (Note 2)		−	−	7.0	−	−	5.0	−	−	9.0	−	−	10	−	−	13	
T_A = T_{low} (Note 2)		−	−	7.0	−	−	5.0	−	−	9.0	−	−	10	−	−	10	
Average Temperature Coefficient of Input Offset Voltage T_A = T_{high} to T_{low} (Notes 2 and 4)	$\Delta V_{IO}/\Delta T$	−	7.0	−	−	7.0	30	−	7.0	−	−	7.0	−	−	7.0	−	μV/°C
Input Offset Current T_A = T_{high} to T_{low} (Note 2)	I_{IO}	− −	3.0 −	30 100	− −	5.0 −	30 75	− −	5.0 −	50 150	− −	5.0 −	50 200	− −	5.0 −	50 200	nA
Average Temperature Coefficient of Input Offset Current T_A = T_{high} to T_{low} (Notes 2 and 4)	$\Delta I_{IO}/\Delta T$	−	10	−	−	10	300	−	10	−	−	10	−	−	10	−	pA/°C
Input Bias Current T_A = T_{high} to T_{low} (Note 2)	I_{IB}	− −	−90 −	−150 −300	− −	−45 −	−100 −200	− −	−90 −	−250 −500	− −	−90 −	−250 −500	− −	−90 −	−250 −500	nA
Input Common Mode Voltage Range (Note 3) V_{CC} = 30 V	V_{ICR}																V
T_A = +25°C		0	−	28.3	0	−	28.3	0	−	28.3	0	−	24.3	0	−	24.3	
T_A = T_{high} to T_{low} (Note 2)		0	−	28	0	−	28	0	−	28	0	−	24	0	−	24	
Differential Input Voltage Range	V_{IDR}	−	−	V_{CC}	−	−	V_{CC}	−	−	V_{CC}	−	−	V_{CC}	−	−	V_{CC}	V
Large Signal Open Loop Voltage Gain R_L = 2.0 kΩ, V_{CC} = 15 V, for Large V_O Swing	A_{VOL}	50	100	−	25	100	−	25	100	−	25	100	−	25	100	−	V/mV
T_A = T_{high} to T_{low} (Note 2)		25	−	−	15	−	−	15	−	−	15	−	−	15	−	−	
Channel Separation 10 kHz ≤ f ≤ 20 kHz, Input Referenced	CS	−	−120	−	−	−120	−	−	−120	−	−	−120	−	−	−120	−	dB
Common Mode Rejection, R_S ≤ 10 kΩ	CMR	70	85	−	65	70	−	65	70	−	50	70	−	50	70	−	dB
Power Supply Rejection	PSR	65	100	−	65	100	−	65	100	−	50	100	−	50	100	−	dB

2. LM224: T_{low} = −25°C, T_{high} = +85°C
   LM324/LM324A: T_{low} = 0°C, T_{high} = +70°C
   LM2902: T_{low} = −40°C, T_{high} = +105°C
   LM2902V & NCV2902: T_{low} = −40°C, T_{high} = +125°C
   NCV2902 is qualified for automotive use.
3. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is V_{CC} −1.7 V.
4. Guaranteed by design.

ELECTRICAL CHARACTERISTICS (V_{CC} = 5.0 V, V_{EE} = GND, T_A = 25°C, unless otherwise noted.)

Characteristics	Symbol	LM224			LM324A			LM324			LM2902			LM2902V/NCV2902			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Output Voltage − High Limit ($T_A = T_{high}$ to T_{low}) (Note 5)	V_{OH}																V
V_{CC} = 5.0 V, R_L = 2.0 kΩ, T_A = 25°C		3.3	3.5	−	3.3	3.5	−	3.3	3.5	−	3.3	3.5	−	3.3	3.5	−	
V_{CC} = 30 V R_L = 2.0 kΩ		26	−	−	26	−	−	26	−	−	22	−	−	22	−	−	
V_{CC} = 30 V R_L = 10 kΩ		27	28	−	27	28	−	27	28	−	23	24	−	23	24	−	
Output Voltage − Low Limit, V_{CC} = 5.0 V, R_L = 10 kΩ, $T_A = T_{high}$ to T_{low} (Note 5)	V_{OL}	−	5.0	20	−	5.0	20	−	5.0	20	−	5.0	100	−	5.0	100	mV
Output Source Current (V_{ID} = +1.0 V, V_{CC} = 15 V)	I_{O+}																mA
T_A = 25°C		20	40	−	20	40	−	20	40	−	20	40	−	20	40	−	
$T_A = T_{high}$ to T_{low} (Note 5)		10	20	−	10	20	−	10	20	−	10	20	−	10	20	−	
Output Sink Current	I_{O-}																mA
(V_{ID} = −1.0 V, V_{CC} = 15 V) T_A = 25°C		10	20	−	10	20	−	10	20	−	10	20	−	10	20	−	
$T_A = T_{high}$ to T_{low} (Note 5)		5.0	8.0	−	5.0	8.0	−	5.0	8.0	−	5.0	8.0	−	5.0	8.0	−	
(V_{ID} = −1.0 V, V_O = 200 mV, T_A = 25°C)		12	50	−	12	50	−	12	50	−	−	−	−	−	−	−	μA
Output Short Circuit to Ground (Note 6)	I_{SC}	−	40	60	−	40	60	−	40	60	−	40	60	−	40	60	mA
Power Supply Current ($T_A = T_{high}$ to T_{low}) (Note 5)	I_{CC}																mA
V_{CC} = 30 V V_O = 0 V, R_L = ∞		−	−	3.0	−	1.4	3.0	−	−	3.0	−	−	3.0	−	−	3.0	
V_{CC} = 5.0 V, V_O = 0 V, R_L = ∞		−	−	1.2	−	0.7	1.2	−	−	1.2	−	−	1.2	−	−	1.2	

5. LM224: T_{low} = −25°C, T_{high} = +85°C
   LM324/LM324A: T_{low} = 0°C, T_{high} = +70°C
   LM2902: T_{low} = −40°C, T_{high} = +105°C
   LM2902V & NCV2902: T_{low} = −40°C, T_{high} = +125°C
   NCV2902 is qualified for automotive use.
6. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is V_{CC} −1.7 V.