

**MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA**

Order this data sheet by LMT324/D

**LMT324, B,
LMT2902**

**Advance Information
Quad Low Power
Operational Amplifiers**

The LMT324, B is a family of quad operational amplifiers with true differential inputs. These devices have several distinct advantages over standard operational amplifiers. 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.

- Short Circuit Protected Outputs
- True Differential Input Stage
- Single Supply Operation: 3.0 to 32 V
- Low Input Bias Currents
- Four Amplifiers per Package
- Internally Compensated
- Common Mode Range Extends to Negative Supply
- Single and Split Supply Operation
- Industry Standard Pinouts

**QUAD
DIFFERENTIAL INPUT
OPERATIONAL AMPLIFIERS**

**SILICON MONOLITHIC
INTEGRATED CIRCUIT**

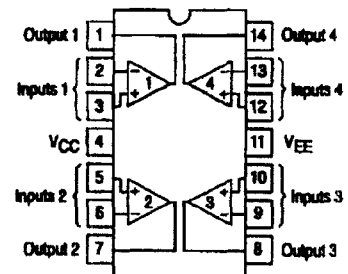


**N SUFFIX
PLASTIC PACKAGE
CASE 646**



**D SUFFIX
PLASTIC PACKAGE
CASE 751A
(SO-14)**

PIN CONNECTIONS



(Quad, Top View)

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$, unless otherwise noted.)

Rating	Symbol	LMT324, LMT324B	LMT2902	Unit
Power Supply Voltages Single Supply Split Supply	V_{CC} V_{CC}, V_{EE}	32 ± 16	26 ± 13	Vdc
Input Differential Voltage Range	V_{IDR}	± 32	± 26	Vdc
Input Common Mode Voltage Range	V_{ICR}	-0.3 to 32	-0.3 to 26	Vdc
Output Short Circuit Duration	t_S	Continuous		sec
Junction Temperature	T_J	150		$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 to +125		$^\circ\text{C}$
Ambient Operating Temperature Range	T_A	0 to +70	-40 to +105	$^\circ\text{C}$

CAUTION: These devices do not have internal ESD protection circuitry and are rated as CLASS 1 devices per the ESD test method in MIL-STD-883D. They should be handled using standard ESD prevention methods to avoid damage to the device.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ORDERING INFORMATION

Device	Temperature Range	Package
LMT324N LMT324D	0° to $+70^\circ\text{C}$	Plastic DIP SO-14
LMT324BN LMT324BD	0° to $+70^\circ\text{C}$	Plastic DIP SO-14
LMT2902N LMT2902D	-40° to $+105^\circ\text{C}$	Plastic DIP SO-14

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XMO10SD21X

ELECTRICAL CHARACTERISTICS ($V_{CC} = +5.0V$, $V_{EE} = \text{Ground}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

Characteristics	Symbol	LMT324			LMT324B			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage, $V_{CC} = 5.0\text{ V to }30\text{ V}$, $V_{ICR} = 0\text{ V to }V_{CC} - 1.7\text{ V}$, $V_O = 1.4\text{ V}$, $R_S = 0\ \Omega$ $T_A = +25^\circ\text{C}$ $T_A = T_{\text{high to }T_{\text{low}}}$ (Note 1)	V_{IO}	—	2.0	7.0	—	2.0	4.5	mV
Average Temp. Coefficient of Input Offset Voltage $T_A = T_{\text{high to }T_{\text{low}}}$	$\Delta V_{IO}/\Delta T$	—	7.0	—	—	7.0	30	$\mu\text{V}/^\circ\text{C}$
Input Offset Current $T_A = T_{\text{high to }T_{\text{low}}}$ (Note 1)	I_{IO}	—	5.0	50	—	5.0	30	nA
Average Temp. Coefficient of Input Offset Current $T_A = T_{\text{high to }T_{\text{low}}}$	$\Delta I_{IO}/\Delta T$	—	10	—	—	10	300	$\text{pA}/^\circ\text{C}$
Input Bias Current $T_A = T_{\text{high to }T_{\text{low}}}$	I_{IB}	—	-90	-250	—	-45	-100	nA
Input Common Mode Voltage Range (Note 2) $V_{CC} = 30\text{ V}$, $T_A = +25^\circ\text{C}$ $V_{CC} = 30\text{ V}$, $T_A = T_{\text{high to }T_{\text{low}}}$	V_{ICR}	0	—	28.3	0	—	28.3	V
Differential Input Voltage Range	V_{IDR}	—	—	V_{CC}	—	—	V_{CC}	V
Large Signal Open-Loop Voltage Gain $R_L = 2.0\text{ k}\Omega$, $V_{CC} = 15\text{ V}$, for Large V_O Swing $T_A = T_{\text{high to }T_{\text{low}}}$	A_{VOL}	25	100	—	25	100	—	V/mV
Channel Separation $1.0\text{ kHz} \leq f \leq 20\text{ kHz}$, Input Referenced	CS	—	-120	—	—	-120	—	dB
Common Mode Rejection Ratio $R_S \leq 10\text{ k}\Omega$	CMRR	65	70	—	65	70	—	dB
Power Supply Rejection Ratio	PSRR	65	100	—	65	100	—	dB
Output Voltage Range	V_{OR}	0	—	3.3	0	—	3.3	V
Output Voltage (High Limit) $V_{CC} = 5.0\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $T_A = +25^\circ\text{C}$ $V_{CC} = 30\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $T_A = T_{\text{high to }T_{\text{low}}}$ $V_{CC} = 30\text{ V}$, $R_L = 10\text{ k}\Omega$, $T_A = T_{\text{high to }T_{\text{low}}}$	V_{OH}	3.3	3.5	—	3.3	3.5	—	V
Output Voltage (Low Limit) $V_{CC} = 5.0\text{ V}$, $R_L = 10\text{ k}\Omega$, $T_A = T_{\text{high to }T_{\text{low}}}$	V_{OL}	—	5.0	20	—	5.0	20	mV
Output Source Current ($V_{ID} = +1.0\text{ V}$, $V_{CC} = 15\text{ V}$) $T_A = T_{\text{high to }T_{\text{low}}}$	I_{O+}	20	40	—	20	40	—	mA
Output Sink Current ($V_{ID} = -1.0\text{ V}$, $V_{CC} = 15\text{ V}$) $T_A = +25^\circ\text{C}$ $T_A = T_{\text{high to }T_{\text{low}}}$ (Note 1) $V_{ID} = -1.0\text{ V}$, $V_O = 200\text{ mV}$, $T_A = +25^\circ\text{C}$	I_{O-}	10	20	—	10	20	—	mA
Output Short Circuit to Ground (Note 3)	I_{SC}	—	40	60	—	40	60	mA
Power Supply Current ($T_A = T_{\text{high to }T_{\text{low}}}$) $V_{CC} = 30\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$ $V_{CC} = 5.0\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$	I_{CC}	—	—	3.0	—	1.4	3.0	mA
		—	—	1.2	—	0.7	1.2	

NOTES: 1. $T_{\text{low}} = 0^\circ\text{C}$, $T_{\text{high}} = +70^\circ\text{C}$ for LMT324, B.
 $T_{\text{low}} = -40^\circ\text{C}$, $T_{\text{high}} = +105^\circ\text{C}$ for LMT2902.

2. The input common mode voltage (V_{ICR}) or either input signal voltage should not be allowed to go negative by more than 0.3 V.

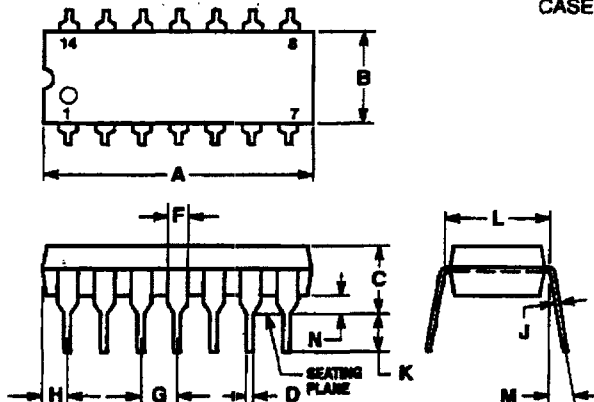
3. Short circuits from the output to V_{CC} can cause excessive heating and eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.

ELECTRICAL CHARACTERISTICS ($V_{CC} = +5.0V$, $V_{EE} = \text{Ground}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

Characteristics	Symbol	LMT2902			Unit
		Min	Typ	Max	
Input Offset Voltage, $V_{CC} = 5.0\text{ V to }30\text{ V}$, $V_{ICR} = 0\text{ V to }V_{CC} - 1.7\text{ V}$, $V_O = 1.4\text{ V}$, $R_S = 0\ \Omega$ $T_A = +25^\circ\text{C}$ $T_A = T_{\text{high to Tlow}}$ (Note 1)	V_{IO}	—	2.0	7.0 10	mV
Average Temp. Coefficient of Input Offset Voltage $T_A = T_{\text{high to Tlow}}$	$\Delta V_{IO}/\Delta T$	—	7.0	—	$\mu\text{V}/^\circ\text{C}$
Input Offset Current $T_A = T_{\text{high to Tlow}}$ (Note 1)	I_{IO}	—	5.0	50 200	nA
Average Temp. Coefficient of Input Offset Current $T_A = T_{\text{high to Tlow}}$	$\Delta I_{IO}/\Delta T$	—	10	—	$\text{pA}/^\circ\text{C}$
Input Bias Current $T_A = T_{\text{high to Tlow}}$	I_{IB}	—	-60	-250 -500	nA
Input Common Mode Voltage Range (Note 2) $V_{CC} = 30\text{ V}$, $T_A = +25^\circ\text{C}$ $V_{CC} = 30\text{ V}$, $T_A = T_{\text{high to Tlow}}$	V_{ICR}	0 0	—	24.3 24	V
Differential Input Voltage Range	V_{IDR}	—	—	V_{CC}	V
Large Signal Open-Loop Voltage Gain $R_L = 2.0\text{ k}\Omega$, $V_{CC} = 15\text{ V}$, for Large V_O Swing $T_A = T_{\text{high to Tlow}}$	A_{VOL}	25 15	100	—	V/mV
Channel Separation $1.0\text{ kHz} \leq f \leq 20\text{ kHz}$, Input Referenced	CS	—	-120	—	dB
Common-Mode Rejection Ratio $R_S \leq 10\text{ k}\Omega$	CMRR	50	70	—	dB
Power Supply Rejection Ratio	PSRR	50	100	—	dB
Output Voltage Range	V_{OR}	0	—	3.3	V
Output Voltage (High Limit) $V_{CC} = 5.0\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $T_A = +25^\circ\text{C}$ $V_{CC} = 30\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $T_A = T_{\text{high to Tlow}}$ $V_{CC} = 30\text{ V}$, $R_L = 10\text{ k}\Omega$, $T_A = T_{\text{high to Tlow}}$	V_{OH}	3.3 22 23	3.5	—	V
Output Voltage (Low Limit) $V_{CC} = 5.0\text{ V}$, $R_L = 10\text{ k}\Omega$, $T_A = T_{\text{high to Tlow}}$	V_{OL}	—	5.0	100	mV
Output Source Current ($V_{ID} = +1.0\text{ V}$, $V_{CC} = 15\text{ V}$) $T_A = T_{\text{high to Tlow}}$	I_{O+}	20 10	40 20	—	mA
Output Sink Current ($V_{ID} = -1.0\text{ V}$, $V_{CC} = 15\text{ V}$) $T_A = +25^\circ\text{C}$ $T_A = T_{\text{high to Tlow}}$ (Note 1) $V_{ID} = -1.0\text{ V}$, $V_O = 200\text{ mV}$, $T_A = +25^\circ\text{C}$	I_{O-}	10 5.0	20 8.0	—	mA mA μA
Output Short Circuit to Ground (Note 3)	I_{SC}	—	40	60	mA
Power Supply Current ($T_A = T_{\text{high to Tlow}}$) $V_{CC} = 30\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$ $V_{CC} = 5.0\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$	I_{CC}	—	—	3.0 1.2	mA

OUTLINE DIMENSIONS

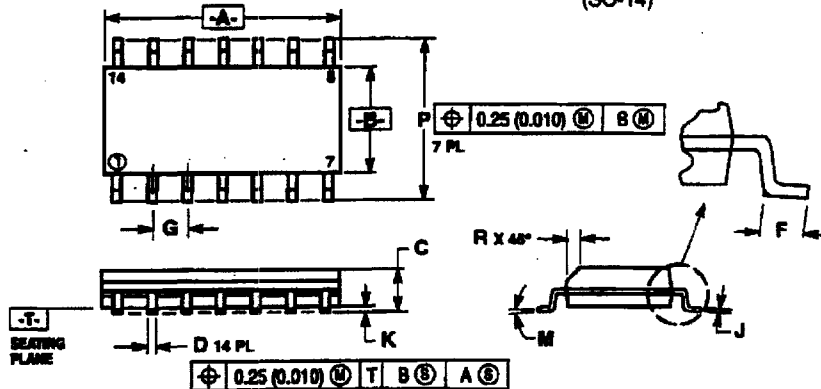
N SUFFIX PLASTIC PACKAGE CASE 848-06



- NOTES:
- LEADS WITHIN 0.13 (0.008) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
 - DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
 - DIMENSION B DOES NOT INCLUDE MOLD FLASH.
 - ROUNDED CORNERS OPTIONAL.


DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.716	0.770	18.16	19.56
B	0.290	0.290	6.16	6.90
C	0.146	0.195	3.69	4.96
D	0.076	0.071	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.082	0.085	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.200 BSC		7.62 BSC	
M	8°	10°	0°	10°
N	0.015	0.030	0.38	1.01

D SUFFIX PLASTIC PACKAGE CASE 751A-03 (SO-14)



- NOTES:
- DIMENSIONING AND TOLERANCING PER ANSI Y14.8M, 1982.
 - CONTROLLING DIMENSION: MILLIMETER.
 - DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
 - MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
 - DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.85	0.75	0.257	0.344
B	3.80	4.60	0.150	0.187
C	1.35	1.75	0.054	0.069
D	0.35	0.30	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.10	0.25	0.004	0.009
K	0.10	0.35	0.004	0.009
M	8°	7°	0°	7°
P	1.50	1.30	0.059	0.344
R	0.25	0.50	0.010	0.019

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LMT324D

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