

# **Single Supply Quad Operational Amplifiers**

# LM324, LM324A, LM324E, LM224, LM2902, LM2902E, LM2902V, NCV2902

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.

- 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 Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

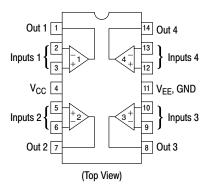




SOIC-14 **D SUFFIX** CASE 751A

TSSOP-14 **DTB SUFFIX CASE 948G** 

#### PIN CONNECTIONS



#### **ORDERING INFORMATION**

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

#### **DEVICE MARKING INFORMATION**

See general marking information in the device marking section on page 11 of this data sheet.

1

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

Rating		Symbol	Value	Unit
Power Supply Voltages Single Supply Split Supplies		V <sub>CC</sub> V <sub>CC</sub> , V <sub>EE</sub>	32 ±16	Vdc
Input Differential Voltage Range (Note 1)		$V_{IDR}$	±32	Vdc
Input Common Mode Voltage Range		V <sub>ICR</sub>	-0.3 to 32	Vdc
Output Short Circuit Duration		t <sub>SC</sub>	Continuous	
Junction Temperature		TJ	150	°C
Thermal Resistance, Junction-to-Air (Note 2)	Case 646 Case 751A Case 948G	$R_{ hetaJA}$	118 156 190	°C/W
Storage Temperature Range		T <sub>stg</sub>	-65 to +150	°C
	LM224 4, LM324A, LM324E LM2902, LM2902E	T <sub>A</sub>	-25 to +85 0 to +70 -40 to +105	°C
LM2902V	/, NCV2902 (Note 3)		-40 to +125	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### **ESD RATINGS**

Rating	нвм	ММ	Unit
ESD Protection at any Pin (Human Body Model - HBM, Machine Model - MM)			
NCV2902 (Note 3)	2000	200	V
LM324E, LM2902E	2000	200	V
LM324DG/DR2G, LM2902DG/DR2G	200	100	V
All Other Devices	2000	200	V

<sup>1.</sup> Split Power Supplies.

<sup>2.</sup> All R<sub>0JA</sub> measurements made on evaluation board with 1 oz. copper traces of minimum pad size. All device outputs were active.

<sup>3.</sup> NCV2902 is qualified for automitive use.

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

			LM224		ĺ	LM324/			324, LM			902, LM	2902E	LM29	902V/NC	V2902	
Characteristics	Symbol	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	Unit
Input Offset Voltage $V_{CC} = 5.0 \text{ V to } 30 \text{ V}$ $V_{ICR} = 0 \text{ V to}$ $V_{CC} -1.7 \text{ V,}$ $V_{O} = 1.4 \text{ V, } R_{S} = 0 \Omega$	V <sub>IO</sub>																mV
$T_A = 25^{\circ}C$ $T_A = T_{high} \text{ (Note 4)}$ $T_A = T_{low} \text{ (Note 4)}$		-	2.0 - -	5.0 7.0 7.0	- - -	2.0 - -	3.0 5.0 5.0	- - -	2.0 - -	7.0 9.0 9.0	-	2.0 - -	7.0 10 10	- - -	2.0 - -	7.0 13 10	
Average Temperature Coefficient of Input Offset Voltage T <sub>A</sub> = T <sub>high</sub> to T <sub>low</sub> (Notes 4 and 6)	ΔV <sub>IO</sub> /ΔΤ	-	7.0	-	-	7.0	30	-	7.0	-	-	7.0	-	-	7.0	_	μV/°C
Input Offset Current  T <sub>A</sub> = T <sub>high</sub> to T <sub>low</sub> (Note 4)	I <sub>IO</sub>	-	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 $T_{low}$	$\Delta I_{IO}/\Delta T$	-	10	-	-	10	300	-	10	-	-	10	-	-	10	-	pA/°C
(Notes 4 and 6)																	
Input Bias Current $T_{A} = T_{high} \text{ to } T_{low}$ (Note 4)	I <sub>IB</sub>	-	-90 -	-150 -300	-	-45 -	-100 -200	-	-90 -	-250 -500	-	-90 -	-250 -500	-	-90 -	-250 -500	nA
Input Common Mode Voltage Range (Note 5) V <sub>CC</sub> = 30 V	V <sub>ICR</sub>																V
$T_A = +25^{\circ}C$ $T_A = T_{high}$ to $T_{low}$ (Note 4)		0	-	28.3 28	0	-	28.3 28	0	-	28.3 28	0	-	28.3 28	0	-	28.3 28	
Differential Input Voltage Range	V <sub>IDR</sub>	-	-	V <sub>CC</sub>	_	_	V <sub>CC</sub>	_	-	V <sub>CC</sub>	-	-	V <sub>CC</sub>	-	_	V <sub>CC</sub>	٧
Large Signal Open Loop Voltage Gain $R_L = 2.0 \text{ k}\Omega$ , $V_{CC} = 15 \text{ V}$ , for Large $V_O$ Swing	Avol	50	100	-	25	100	-	25	100	-	25	100	-	25	100	-	V/mV
$T_A = T_{high}$ to $T_{low}$ (Note 4)		25	-		15	_	_	15	-	_	15	_	_	15	_	-	
Channel Separation 10 kHz $\leq$ f $\leq$ 20 kHz, Input Referenced	CS	-	-120	-	-	-120	-	-	-120	-	-	-120	-	-	-120	-	dB
Common Mode Rejection, $R_S \le 10 \text{ k}\Omega$	CMR	70	85	_	65	70	-	65	70	-	50	70	-	50	70	-	dΒ
Power Supply Rejection	PSR	65	100	-	65	100	_	65	100	_	50	100	-	50	100	-	dB

4. LM224: T<sub>low</sub> = -25°C, T<sub>high</sub> = +85°C LM324/LM324A/LM324E: T<sub>low</sub> = 0°C, T<sub>high</sub> = +70°C LM2902/LM2902E: T<sub>low</sub> = -40°C, T<sub>high</sub> = +105°C LM2902V & NCV2902: T<sub>low</sub> = -40°C, T<sub>high</sub> = +125°C

NCV2902 is qualified for automotive use.

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<sub>CC</sub> –1.7 V, but either or both inputs can go to +32 V without damage, independent of the magnitude
of V<sub>CC</sub>.

6. Guaranteed by design.

**ELECTRICAL CHARACTERISTICS** (V<sub>CC</sub> = 5.0 V, V<sub>EE</sub> = GND, T<sub>A</sub> = 25°C, unless otherwise noted.)

			LM224	ļ		LM324/	4	LM	324, LM	324E	LM29	902, LM	2902E	LM29	02V/NC	V2902	
Characteristics	Symbol	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	Unit
Output Voltage – High Limit $V_{CC} = 5.0 \text{ V, } R_L = \\ 2.0 \text{ k}\Omega, T_A = 25^{\circ}\text{C}$ $V_{CC} = 30 \text{ V}$ $R_L = 2.0 \text{ k}\Omega$ $(T_A = T_{high \text{ to }} T_{low})$	V <sub>OH</sub>	3.3	3.5	-	3.3 26	3.5	-	3.3 26	3.5	-	3.3 26	3.5	-	3.3 26	3.5	-	V
(Note 7) $V_{CC} = 30 \text{ V}$ $R_L = 10 \text{ k}\Omega$ $(T_A = T_{high \text{ to}} T_{low})$ (Note 7)		27	28	-	27	28	-	27	28	-	27	28	-	27	28	-	
$\label{eq:continuity} \begin{split} & \text{Output Voltage} - \\ & \text{Low Limit,} \\ & \text{V}_{CC} = 5.0 \text{ V,} \\ & \text{R}_L = 10 \text{ k}\Omega, \\ & \text{T}_A = \text{T}_{high} \text{ to T}_{low} \\ & \text{(Note 7)} \end{split}$	V <sub>OL</sub>	-	5.0	20	-	5.0	20	-	5.0	20	-	5.0	100	-	5.0	100	mV
Output Source Current $(V_{ID} = +1.0 \text{ V}, \\ V_{CC} = 15 \text{ V})$ $T_A = 25^{\circ}\text{C}$ $T_A = T_{high} \text{ to } T_{low}$ (Note 7)	I <sub>O+</sub>	20 10	40 20	- -	20 10	40 20	- -	20 10	40 20	-	20 10	40 20		20 10	40 20	-	mA
Output Sink Current $(V_{ID} = -1.0 \text{ V},$ $V_{CC} = 15 \text{ V})$ $T_{A} = 25^{\circ}\text{C}$ $T_{A} = T_{high} \text{ to } T_{low}$ (Note 7)	I <sub>O</sub> _	10 5.0	20	-	10 5.0	20	-	10 5.0	20	-	10 5.0	20	-	10 5.0	20	-	mA
(Note 7) $(V_{ID} = -1.0 \text{ V},$ $V_{O} = 200 \text{ mV},$ $T_{A} = 25^{\circ}\text{C})$		12	50	-	12	50	-	12	50	-	-	-	-	_	-	-	μΑ
Output Short Circuit to Ground (Note 8)	I <sub>SC</sub>	-	40	60	-	40	60	-	40	60	-	40	60	_	40	60	mA
Power Supply Current $(T_A = T_{high} \text{ to } T_{low})$ (Note 7)	I <sub>CC</sub>																mA
$V_{CC} = 30 \text{ V}$ $V_{O} = 0 \text{ V}, R_{L} = \infty$ $V_{CC} = 5.0 \text{ V},$		_	-	3.0	_	0.7	3.0	_	_	3.0	_	-	3.0	_	-	3.0	
$V_{CC} = 5.0 \text{ V},$ $V_{O} = 0 \text{ V}, R_{L} = \infty$				1.2		0.1	1.2			1.2			1.2		_	1.2	

7. LM224: T<sub>low</sub> = -25°C, T<sub>high</sub> = +85°C LM324/LM324A/LM324E: T<sub>low</sub> = 0°C, T<sub>high</sub> = +70°C LM2902/LM2902E: T<sub>low</sub> = -40°C, T<sub>high</sub> = +105°C LM2902V & NCV2902: T<sub>low</sub> = -40°C, T<sub>high</sub> = +125°C NCV2902 is qualified for automotive use.

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

<sup>8.</sup> 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<sub>CC</sub> –1.7 V, but either or both inputs can go to +32 V without damage, independent of the magnitude

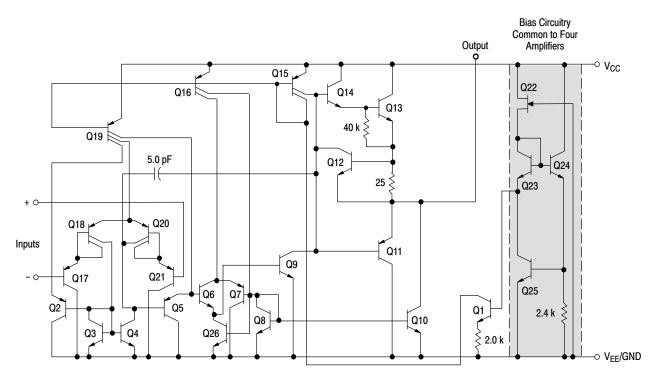


Figure 1. Representative Circuit Diagram (One–Fourth of Circuit Shown)

#### CIRCUIT DESCRIPTION

The LM324 series is made using four internally compensated, two-stage operational amplifiers. The first stage of each consists of differential input devices Q20 and Q18 with input buffer transistors Q21 and Q17 and the differential to single ended converter Q3 and Q4. The first stage performs not only the first stage gain function but also performs the level shifting and transconductance reduction functions. By reducing the transconductance, a smaller compensation capacitor (only 5.0 pF) can be employed, thus saving chip area. The transconductance reduction is accomplished by splitting the collectors of Q20 and Q18. Another feature of this input stage is that the input common mode range can include the negative supply or ground, in single supply operation, without saturating either the input devices or the differential to single-ended converter. The second stage consists of a standard current source load amplifier stage.

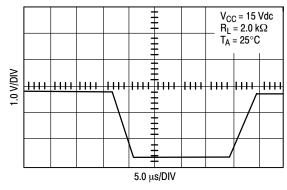
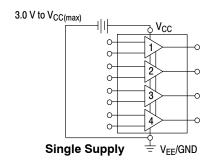


Figure 2. Large Signal Voltage Follower Response

Each amplifier is biased from an internal-voltage regulator which has a low temperature coefficient thus giving each amplifier good temperature characteristics as well as excellent power supply rejection.



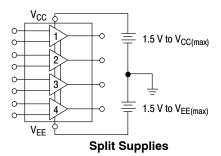


Figure 3.

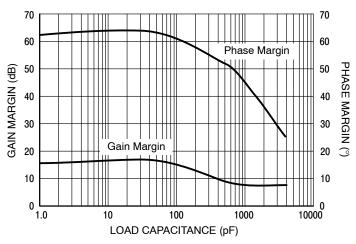


Figure 4. Gain and Phase Margin

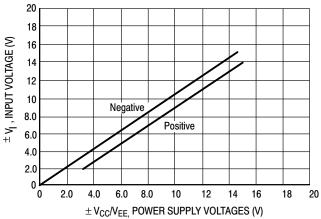


Figure 5. Input Voltage Range

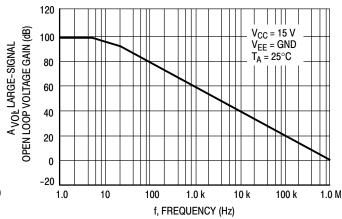


Figure 6. Open Loop Frequency

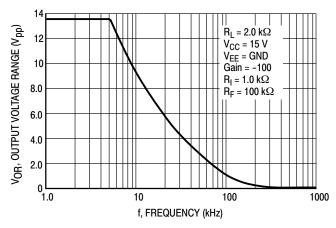


Figure 7. Large-Signal Frequency Response

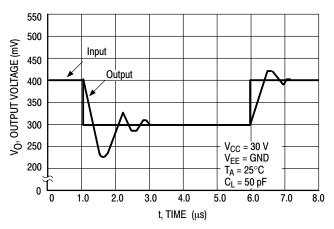


Figure 8. Small-Signal Voltage Follower Pulse Response (Noninverting)

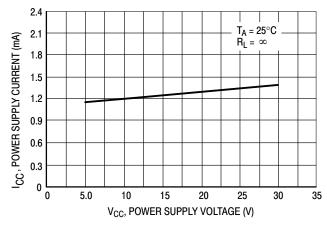


Figure 9. Power Supply Current versus Power Supply Voltage

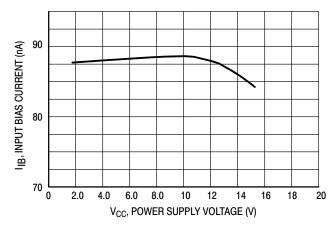


Figure 10. Input Bias Current versus Power Supply Voltage

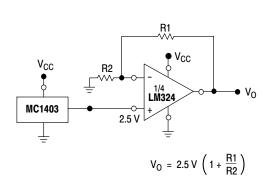


Figure 11. Voltage Reference

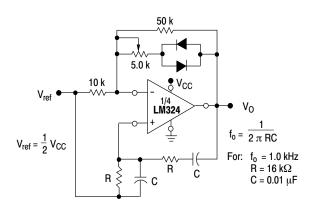


Figure 12. Wien Bridge Oscillator

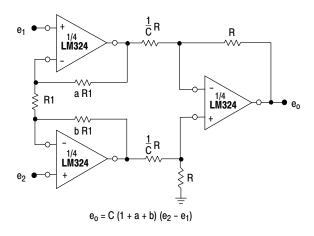


Figure 13. High Impedance Differential Amplifier

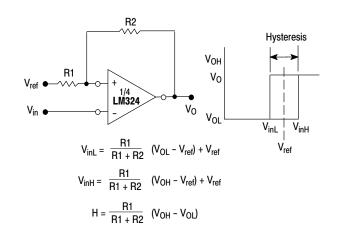


Figure 14. Comparator with Hysteresis

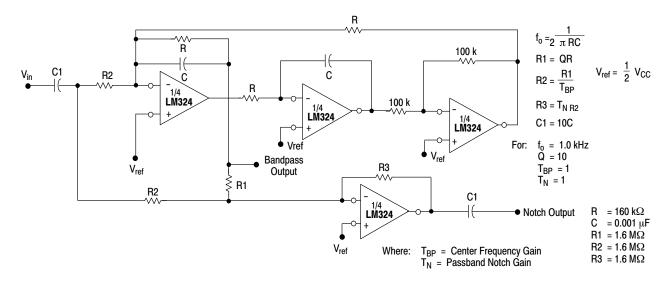


Figure 15. Bi-Quad Filter

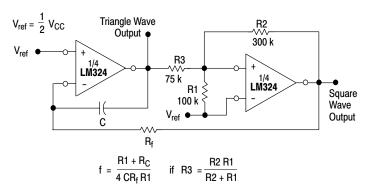


Figure 16. Function Generator

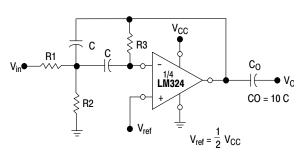


Figure 17. Multiple Feedback Bandpass Filter

Given:  $f_0$  = center frequency

A(f<sub>0</sub>) = gain at center frequency

Choose value f<sub>0</sub>, C

Then: R3 = 
$$\frac{Q}{\pi f_0 C}$$

For less than 10% error from operational amplifier,  $\frac{Q_0}{BW} < 0.1$ 

where fo and BW are expressed in Hz.

If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters.

### **ORDERING INFORMATION**

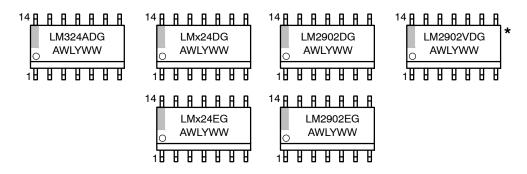
Device	Operating Temperature Range	Package	Shipping <sup>†</sup>
LM224DR2G	-25°C to +85°C	SOIC-14 (Pb-Free)	2500/Tape & Reel
LM224DTBR2G	-25°C to +85°C	TSSOP-14 (Pb-Free)	2500/Tape & Reel
LM324DR2G		SOIC-14 (Pb-Free)	2500/Tape & Reel
LM324EDR2G		SOIC-14 (Pb-Free)	2500/Tape & Reel
LM324DTBR2G	0°C to +70°C	TSSOP-14 (Pb-Free)	2500/Tape & Reel
LM324ADR2G		SOIC-14 (Pb-Free)	2500/Tape & Reel
LM324ADTBR2G		TSSOP-14 (Pb-Free)	2500/Tape & Reel
LM2902DR2G		SOIC-14 (Pb-Free)	2500/Tape & Reel
LM2902EDR2G	−40°C to +105°C	SOIC-14 (Pb-Free)	2500/Tape & Reel
LM2902DTBR2G		TSSOP-14 (Pb-Free)	2500/Tape & Reel
LM2902VDR2G		SOIC-14 (Pb-Free)	2500/Tape & Reel
LM2902VDTBR2G	4000 1- 40500	TSSOP-14 (Pb-Free)	2500/Tape & Reel
NCV2902DR2G*	−40°C to +125°C	SOIC-14 (Pb-Free)	0500/Tone 9 Deel
NCV2902DTBR2G*		TSSOP-14 (Pb-Free)	2500/Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
\*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP

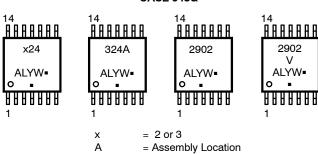
Capable.

#### **MARKING DIAGRAMS**

#### SOIC-14 D SUFFIX CASE 751A



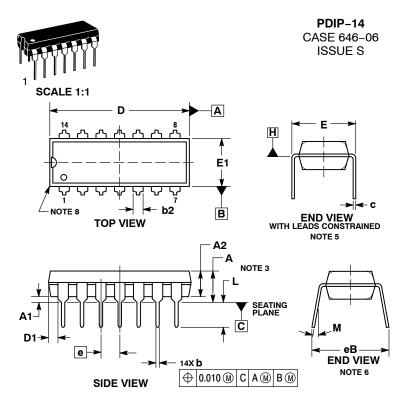
#### TSSOP-14 DTB SUFFIX CASE 948G



WL, L = Wafer Lot YY, Y = Year

WW, W = Work Week
G or ■ = Pb-Free Package

(Note: Microdot may be in either location) \*This marking diagram also applies to NCV2902.



**DATE 22 APR 2015** 

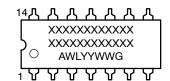
#### NOTES:

- 1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: INCHES.
  3. DIMENSIONS A, A1 AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS-3.
  4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE
- NOT TO EXCEED 0.10 INCH.
  DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
- DIMENSION 6B IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
- DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.

  PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE
- CORNERS).

	INC	HES	MILLIM	ETERS		
DIM	MIN	MAX	MIN	MAX		
Α		0.210		5.33		
A1	0.015		0.38			
A2	0.115	0.195	2.92	4.95		
b	0.014	0.022	0.35	0.56		
b2	0.060	TYP	1.52	1.52 TYP		
С	0.008	0.014	0.20	0.36		
D	0.735	0.775	18.67	19.69		
D1	0.005		0.13			
Е	0.300	0.325	7.62	8.26		
E1	0.240	0.280	6.10	7.11		
е	0.100	BSC	2.54	BSC		
eB		0.430		10.92		
L	0.115	0.150	2.92	3.81		
М		10°		10°		

#### **GENERIC MARKING DIAGRAM\***



XXXXX = Specific Device Code = Assembly Location

WL = Wafer Lot YY = Year WW = Work Week = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot " ■", may or may not be present.

# **STYLES ON PAGE 2**

DOCUMENT NUMBER:	98ASB42428B	Electronic versions are uncontrolled except when accessed directly from the Document Repo Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.			
DESCRIPTION:	PDIP-14		PAGE 1 OF 2		

ON Semiconductor and unare trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. ON Semiconductor does not convey any license under its patent rights nor the rights of others.

### PDIP-14 CASE 646-06 ISSUE S

# **DATE 22 APR 2015**

STYLE 1: PIN 1. COLLECTOR 2. BASE 3. EMITTER 4. NO CONNECTION 5. EMITTER 6. BASE 7. COLLECTOR 8. COLLECTOR 9. BASE 10. EMITTER 11. NO CONNECTION 12. EMITTER 13. BASE 14. COLLECTOR	STYLE 2: CANCELLED	STYLE 3: CANCELLED	STYLE 4: PIN 1. DRAIN 2. SOURCE 3. GATE 4. NO CONNECTION 5. GATE 6. SOURCE 7. DRAIN 8. DRAIN 9. SOURCE 10. GATE 11. NO CONNECTION 12. GATE 13. SOURCE 14. DRAIN
STYLE 5: PIN 1. GATE 2. DRAIN 3. SOURCE 4. NO CONNECTION 5. SOURCE 6. DRAIN 7. GATE 8. GATE 9. DRAIN 10. SOURCE 11. NO CONNECTION 12. SOURCE 13. DRAIN 14. GATE	STYLE 6: PIN 1. COMMON CATHODE 2. ANODE/CATHODE 3. ANODE/CATHODE 4. NO CONNECTION 5. ANODE/CATHODE 6. NO CONNECTION 7. ANODE/CATHODE 8. ANODE/CATHODE 9. ANODE/CATHODE 10. NO CONNECTION 11. ANODE/CATHODE 12. ANODE/CATHODE 13. NO CONNECTION 14. COMMON ANODE	STYLE 7: PIN 1. NO CONNECTION 2. ANODE 3. ANODE 4. NO CONNECTION 5. ANODE 6. NO CONNECTION 7. ANODE 8. ANODE 9. ANODE 10. NO CONNECTION 11. ANODE 12. ANODE 13. NO CONNECTION 14. COMMON CATHODE	STYLE 8: PIN 1. NO CONNECTION 2. CATHODE 3. CATHODE 4. NO CONNECTION 5. CATHODE 6. NO CONNECTION 7. CATHODE 8. CATHODE 9. CATHODE 10. NO CONNECTION 11. CATHODE 12. CATHODE 13. NO CONNECTION 14. COMMON ANODE
STYLE 9: PIN 1. COMMON CATHODE 2. ANODE/CATHODE 3. ANODE/CATHODE 4. NO CONNECTION 5. ANODE/CATHODE 6. ANODE/CATHODE 7. COMMON ANODE 8. COMMON ANODE 9. ANODE/CATHODE 10. ANODE/CATHODE 11. NO CONNECTION 12. ANODE/CATHODE 13. ANODE/CATHODE 14. COMMON CATHODE	STYLE 10: PIN 1. COMMON CATHODE 2. ANODE/CATHODE 3. ANODE/CATHODE 4. ANODE/CATHODE 5. ANODE/CATHODE 6. NO CONNECTION 7. COMMON ANODE 8. COMMON CATHODE 9. ANODE/CATHODE 10. ANODE/CATHODE 11. ANODE/CATHODE 12. ANODE/CATHODE 13. NO CONNECTION 14. COMMON ANODE	STYLE 11: PIN 1. CATHODE 2. CATHODE 3. CATHODE 4. CATHODE 5. CATHODE 6. CATHODE 7. CATHODE 8. ANODE 9. ANODE 10. ANODE 11. ANODE 12. ANODE 13. ANODE 14. ANODE	STYLE 12: PIN 1. COMMON CATHODE 2. COMMON ANODE 3. ANODE/CATHODE 4. ANODE/CATHODE 5. ANODE/CATHODE 6. COMMON ANODE 7. COMMON CATHODE 8. ANODE/CATHODE 9. ANODE/CATHODE 10. ANODE/CATHODE 11. ANODE/CATHODE 12. ANODE/CATHODE 13. ANODE/CATHODE 14. ANODE/CATHODE 14. ANODE/CATHODE

DOCUMENT NUMBER:	98ASB42428B	Electronic versions are uncontrolled except when accessed directly from the Document Reposi Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.			
DESCRIPTION:	PDIP-14		PAGE 2 OF 2		

ON Semiconductor and IN are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. ON Semiconductor does not convey any license under its patent rights nor the rights of others.

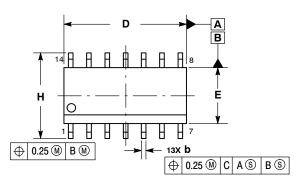




△ 0.10

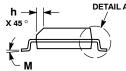
SOIC-14 NB CASE 751A-03 ISSUE L

**DATE 03 FEB 2016** 









- NOTES:
  1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  CONTROLLING DIMENSION: MILLIMETERS.
  - DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION
  - SHALL BE 0.13 TOTAL IN EXCESS OF AT
  - MAXIMUM MATERIAL CONDITION.
    DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
- 5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE

	MILLIN	IETERS	INC	HES	
DIM	MIN	MAX	MIN	MAX	
Α	1.35	1.75	0.054	0.068	
A1	0.10	0.25	0.004	0.010	
АЗ	0.19	0.25	0.008	0.010	
b	0.35	0.49	0.014	0.019	
D	8.55	8.75	0.337	0.344	
Е	3.80	4.00	0.150	0.157	
е	1.27	BSC	0.050 BSC		
Н	5.80	6.20	0.228	0.244	
h	0.25	0.50	0.010	0.019	
L	0.40	1.25	0.016	0.049	
M	0 °	7°	0 °	7°	

#### **GENERIC MARKING DIAGRAM\***

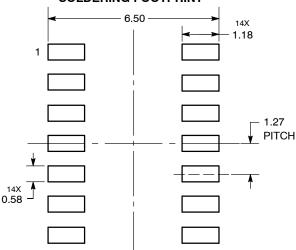


XXXXX = Specific Device Code Α = Assembly Location

WL = Wafer Lot Υ = Year WW = Work Week = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

# **SOLDERING FOOTPRINT\***



DIMENSIONS: MILLIMETERS

C SEATING PLANE

#### **STYLES ON PAGE 2**

DOCUMENT NUMBER:	98ASB42565B	Electronic versions are uncontrolled except when accessed directly from the Document Repos Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.			
DESCRIPTION:	SOIC-14 NB		PAGE 1 OF 2		

onsemi and ONSEMI are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. **onsemi** does not convey any license under its patent rights nor the rights of others.

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

## SOIC-14 CASE 751A-03 ISSUE L

# DATE 03 FEB 2016

STYLE 1: PIN 1. COMMON CATHODE 2. ANODE/CATHODE 3. ANODE/CATHODE 4. NO CONNECTION 5. ANODE/CATHODE 6. NO CONNECTION 7. ANODE/CATHODE 8. ANODE/CATHODE 9. ANODE/CATHODE 10. NO CONNECTION 11. ANODE/CATHODE 12. ANODE/CATHODE 13. NO CONNECTION 14. COMMON ANODE	STYLE 2: CANCELLED	STYLE 3: PIN 1. NO CONNECTION 2. ANODE 3. ANODE 4. NO CONNECTION 5. ANODE 6. NO CONNECTION 7. ANODE 8. ANODE 9. ANODE 10. NO CONNECTION 11. ANODE 12. ANODE 13. NO CONNECTION 14. COMMON CATHODE	STYLE 4: PIN 1. NO CONNECTION 2. CATHODE 3. CATHODE 4. NO CONNECTION 5. CATHODE 6. NO CONNECTION 7. CATHODE 8. CATHODE 9. CATHODE 10. NO CONNECTION 11. CATHODE 12. CATHODE 13. NO CONNECTION 14. COMMON ANODE
STYLE 5: PIN 1. COMMON CATHODE 2. ANODE/CATHODE 3. ANODE/CATHODE 4. ANODE/CATHODE 5. ANODE/CATHODE 6. NO CONNECTION 7. COMMON ANODE 8. COMMON CATHODE 9. ANODE/CATHODE 10. ANODE/CATHODE 11. ANODE/CATHODE 12. ANODE/CATHODE 13. NO CONNECTION 14. COMMON ANODE	STYLE 6: PIN 1. CATHODE 2. CATHODE 3. CATHODE 4. CATHODE 5. CATHODE 6. CATHODE 7. CATHODE 8. ANODE 9. ANODE 10. ANODE 11. ANODE 12. ANODE 13. ANODE 14. ANODE	STYLE 7: PIN 1. ANODE/CATHODE 2. COMMON ANODE 3. COMMON CATHODE 4. ANODE/CATHODE 5. ANODE/CATHODE 6. ANODE/CATHODE 7. ANODE/CATHODE 8. ANODE/CATHODE 9. ANODE/CATHODE 10. ANODE/CATHODE 11. COMMON CATHODE 12. COMMON ANODE 13. ANODE/CATHODE 14. ANODE/CATHODE	STYLE 8: PIN 1. COMMON CATHODE 2. ANODE/CATHODE 3. ANODE/CATHODE 4. NO CONNECTION 5. ANODE/CATHODE 6. ANODE/CATHODE 7. COMMON ANODE 8. COMMON ANODE 9. ANODE/CATHODE 10. ANODE/CATHODE 11. NO CONNECTION 12. ANODE/CATHODE 13. ANODE/CATHODE 14. COMMON CATHODE

DOCUMENT NUMBER:	98ASB42565B	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.	
DESCRIPTION:	SOIC-14 NB		PAGE 2 OF 2

onsemi and ONSEMi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.

onsemi, ONSEMI., and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries. onsemi owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of onsemi's product/patent coverage may be accessed at <a href="www.onsemi.com/site/pdf/Patent-Marking.pdf">www.onsemi.com/site/pdf/Patent-Marking.pdf</a>. onsemi reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and onsemi makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems. or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

#### ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:

 $\textbf{Technical Library:} \ \underline{www.onsemi.com/design/resources/technical-documentation}$ 

onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support

For additional information, please contact your local Sales Representative at

www.onsemi.com/support/sales