



# THE DATASHEET OF LM348N/NOPB

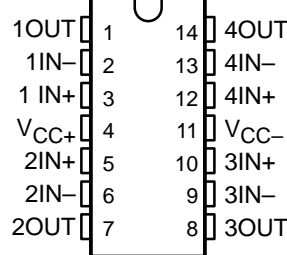


# LM148, LM248, LM348 QUADRUPLE OPERATIONAL AMPLIFIERS

SLOS058C – OCTOBER 1979 – REVISED DECEMBER 2002

- $\mu$ A741 Operating Characteristics
- Low Supply-Current Drain . . . 0.6 mA Typ (per amplifier)
- Low Input Offset Voltage
- Low Input Offset Current
- Class AB Output Stage
- Input/Output Overload Protection
- Designed to Be Interchangeable With Industry Standard LM148, LM248, and LM348

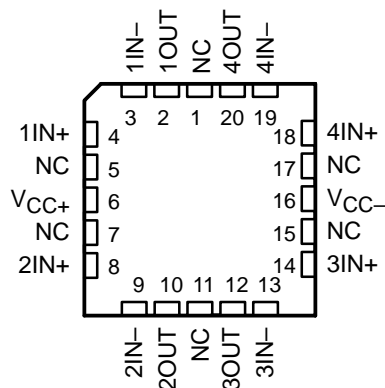
LM148 . . . J PACKAGE  
LM248 . . . D OR N PACKAGE  
LM348 . . . D, N, OR NS PACKAGE  
(TOP VIEW)



## description/ordering information

The LM148, LM248, and LM348 are quadruple, independent, high-gain, internally compensated operational amplifiers designed to have operating characteristics similar to the  $\mu$ A741. These amplifiers exhibit low supply-current drain and input bias and offset currents that are much less than those of the  $\mu$ A741.

LM148 . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection

## ORDERING INFORMATION

$T_A$	$V_{IOmax}$ AT 25°C	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	6 mV	PDIP (N)	Tube of 25	LM348N	LM348N
		SOIC (D)	Tube of 50	LM348D	LM348
			Reel of 2500	LM348DR	
–25°C to 85°C	6 mV	SOP (NS)	Reel of 2000	LM348NSR	LM348
		PDIP (N)	Tube of 25	LM248N	LM248N
			SOIC (D)	Tube of 50	LM248D
Reel of 2500	LM248DR				
–55°C to 125°C	5 mV	CDIP (J)	Tube of 25	LM148J	LM148J
		LCCC (FK)	Tube of 50	LM148FK	LM148FK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

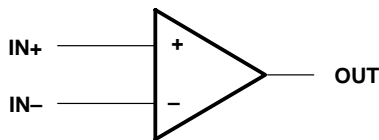
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2002, Texas Instruments Incorporated  
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# LM148, LM248, LM348 QUADRUPLE OPERATIONAL AMPLIFIERS

SLOS058C – OCTOBER 1979 – REVISED DECEMBER 2002

## symbol (each amplifier)



## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{CC+}$ (see Note 1):	LM148	22 V
	LM248, LM348	18 V
Supply voltage, $V_{CC-}$ (see Note 1):	LM148	-22 V
	LM248, LM348	-18 V
Differential input voltage, $V_{ID}$ (see Note 2):	LM148	44 V
	LM248, LM348	36 V
Input voltage, $V_I$ (either input, see Notes 1 and 3):	LM148	-22 V
	LM248, LM348	-18 V
Duration of output short circuit (see Note 4)		Unlimited
Operating virtual junction temperature, $T_J$		150°C
Package thermal impedance, $\theta_{JA}$ (see Notes 5 and 6):	D package	86°C/W
	N package	80°C/W
	NS package	76°C/W
Package thermal impedance, $\theta_{JC}$ (see Notes 7 and 8):	FK package	5.61°C/W
	J package	15.05°C/W
Case temperature for 60 seconds: FK package		260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: J package		300°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: D, N, or NS package		260°C
Storage temperature range, $T_{stg}$		-65°C to 150°C

† Stresses beyond 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-rated conditions for extended periods may affect device reliability.

- NOTES:
1. All voltage values, unless otherwise noted, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .
  2. Differential voltages are at  $IN+$  with respect to  $IN-$ .
  3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or the value specified in the table, whichever is less.
  4. The output may be shorted to ground or either power supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.
  5. Maximum power dissipation is a function of  $T_J(max)$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(max) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  6. The package thermal impedance is calculated in accordance with JESD 51-7.
  7. Maximum power dissipation is a function of  $T_J(max)$ ,  $\theta_{JC}$ , and  $T_C$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(max) - T_C)/\theta_{JC}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  8. The package thermal impedance is calculated in accordance with MIL-STD-883.

## recommended operating conditions

	MIN	MAX	UNIT
Supply voltage, $V_{CC+}$	4	18	V
Supply voltage, $V_{CC-}$	-4	-18	V



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

PARAMETER	TEST CONDITION <sup>†</sup>	LM148			LM248		
		MIN	TYP	MAX	MIN	TYP	MAX
$V_{IO}$ Input offset voltage	$V_O = 0$	25°C	1	5	1	1	6
		Full range		6			7.5
$I_{IO}$ Input offset current	$V_O = 0$	25°C	4	25	4	4	50
		Full range		75			125
$I_{IB}$ Input bias current	$V_O = 0$	25°C	30	100	30	30	200
		Full range		325			500
$V_{ICR}$ Common-mode input voltage range		Full range	$\pm 12$		$\pm 12$		$\pm 12$
$V_{OM}$ Maximum peak output voltage swing		25°C	$\pm 12$	$\pm 13$	$\pm 12$	$\pm 13$	$\pm 12$
		Full range	$\pm 12$		$\pm 12$		
		25°C	$\pm 10$	$\pm 12$	$\pm 10$	$\pm 12$	$\pm 10$
		Full range	$\pm 10$		$\pm 10$		$\pm 10$
AVD Large-signal differential voltage amplification	$V_O = \pm 10$ V, $R_L \geq 2$ k $\Omega$	25°C	50	160	25	160	20
		Full range	25		15		10
$r_i$ Input resistance <sup>‡</sup>		25°C	0.8	2.5	0.8	2.5	0.7
$B_1$ Unity-gain bandwidth	AVD = 1	25°C		1		1	
$\phi_m$ Phase margin	AVD = 1	25°C		60°		60°	
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$ , $V_O = 0$	25°C	70	90	70	90	70
kSVR Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 9$ V to $\pm 15$ V, $V_O = 0$	Full range	77	96	77	96	77
		Full range	77		77		77
IOS Short-circuit output current		25°C	$\pm 25$		$\pm 25$		$\pm 25$
ICC Supply current (four amplifiers)	No load	$V_O = 0$					
		$V_O = V_{OM}$					
$V_{O1}/V_{O2}$ Crosstalk attenuation	f = 1 Hz to 20 kHz	25°C	2.4	3.6	2.4	4.5	
			120		120		

<sup>†</sup> All characteristics are measured under open-loop conditions with zero common-mode input voltage, unless otherwise specified. Full range for LM148, -25°C to 85°C for LM248, and 0°C to 70°C for LM348.

<sup>‡</sup> This parameter is not production tested.

# LM148, LM248, LM348 QUADRUPLE OPERATIONAL AMPLIFIERS

SLOS058C – OCTOBER 1979 – REVISED FEBRUARY 2002

operating characteristics,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR Slew rate at unity gain	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , See Figure 1		0.5		$\text{V}/\mu\text{s}$

## PARAMETER MEASUREMENT INFORMATION

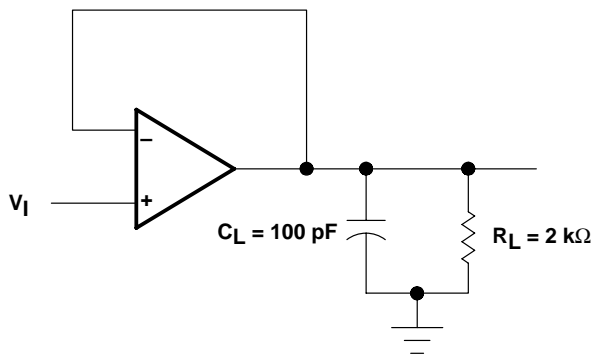


Figure 1. Unity-Gain Amplifier

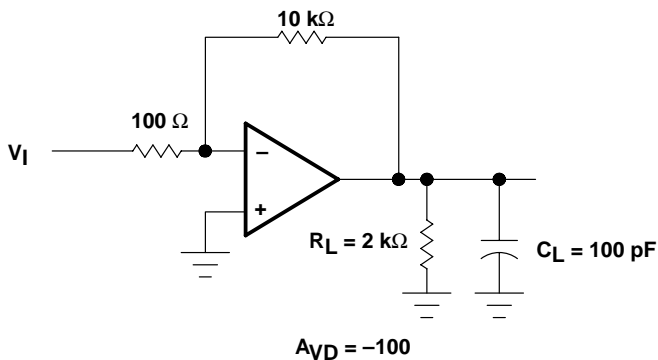


Figure 2. Inverting Amplifier

J (R-GDIP-T\*\*)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



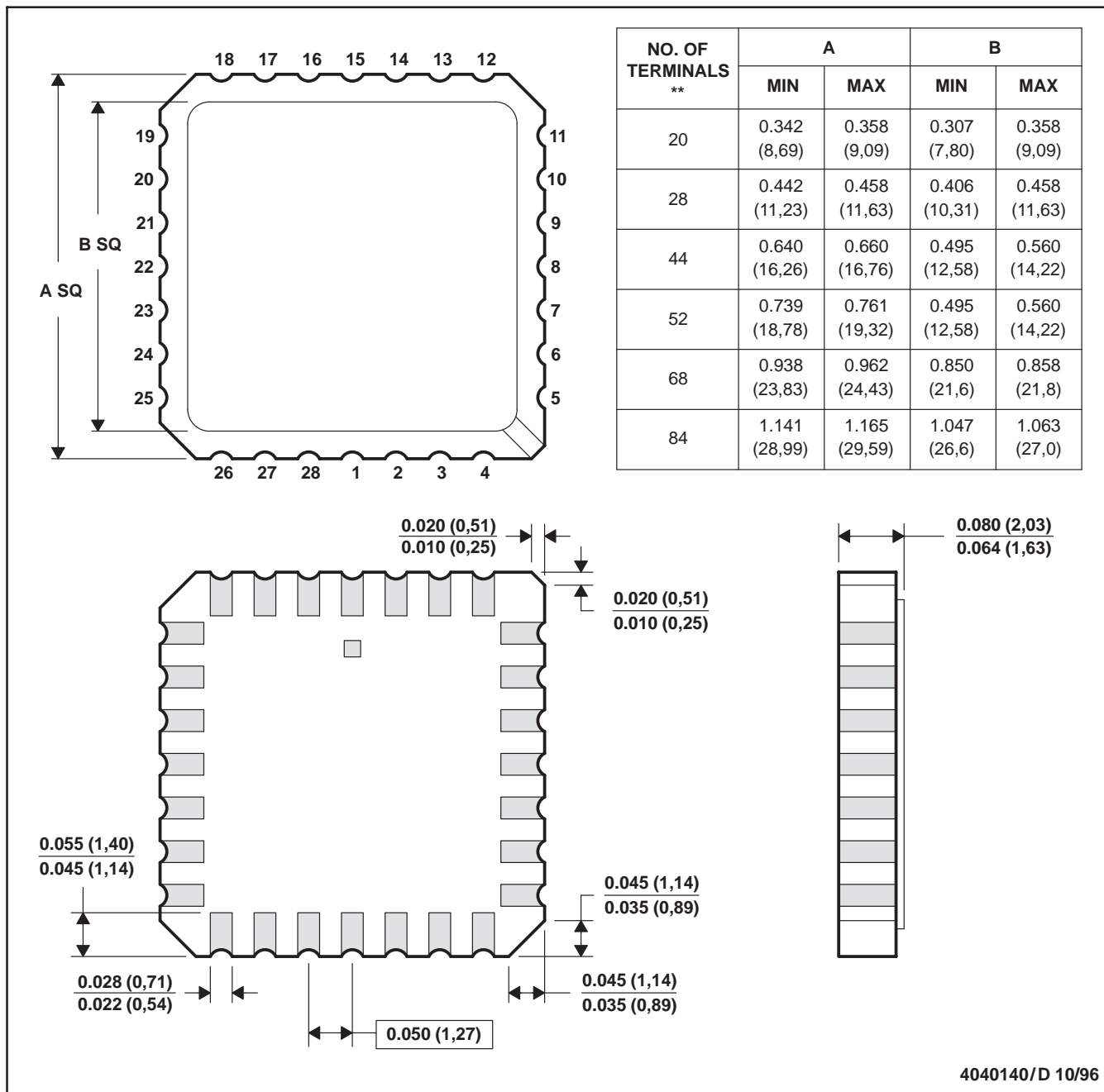
4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package is hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN

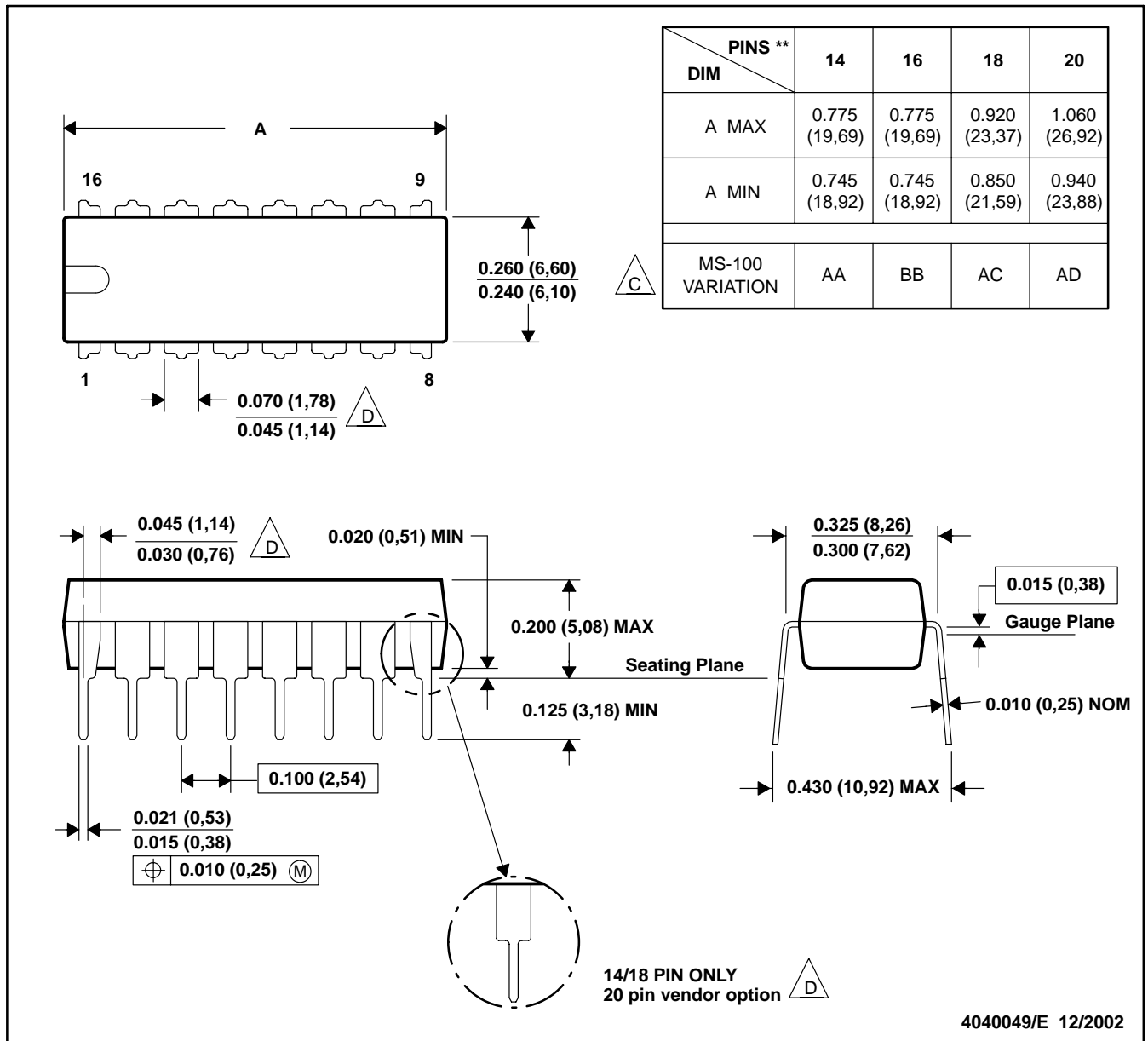


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a metal lid.
  - D. The terminals are gold plated.
  - E. Falls within JEDEC MS-004

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN

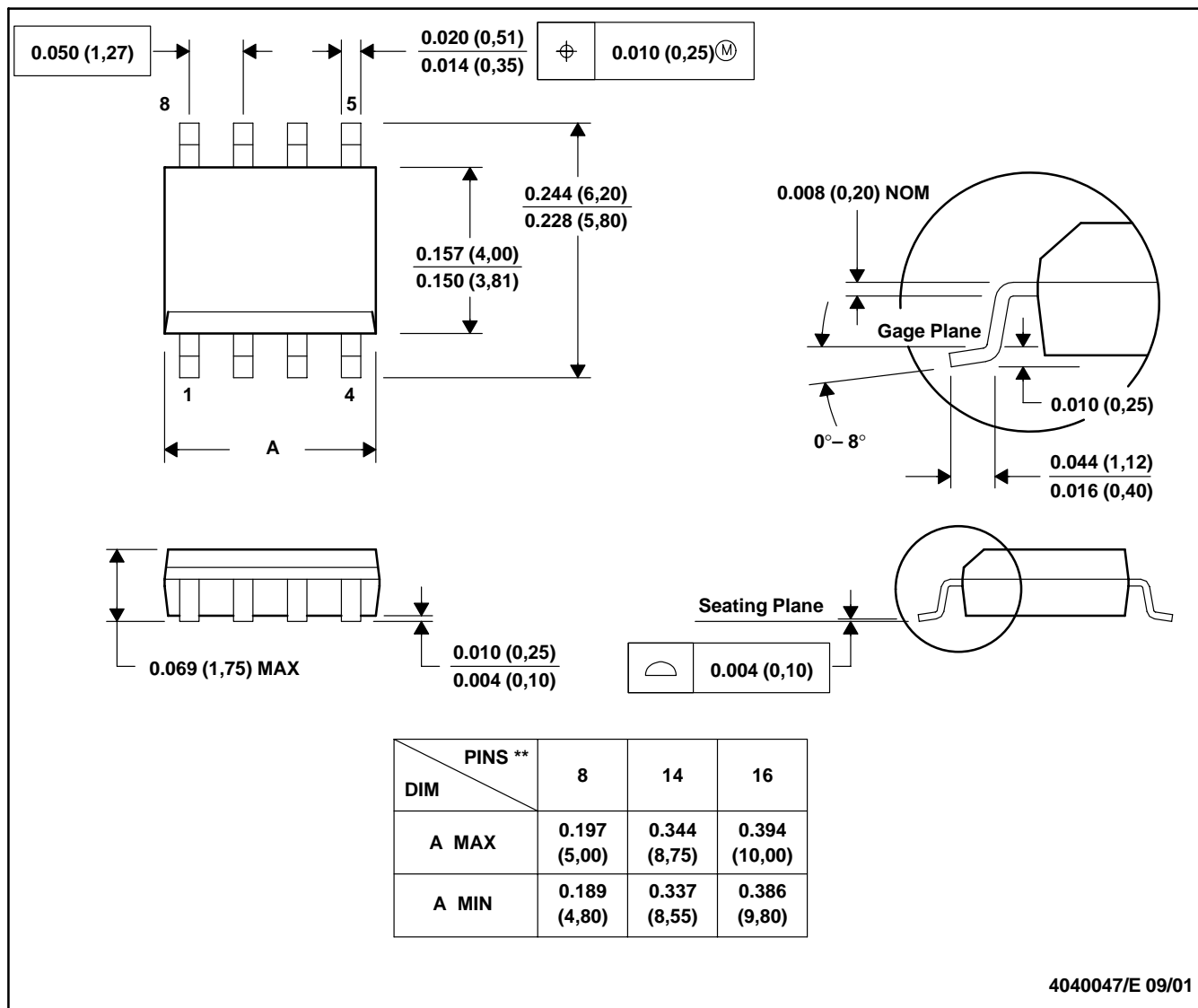


- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).  
 D The 20 pin end lead shoulder width is a vendor option, either half or full width.

D (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

8 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MS-012

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

### Mailing Address:

Texas Instruments  
Post Office Box 655303  
Dallas, Texas 75265

## Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

 [View LM348N/NOPB on WIN SOURCE](#)

 [Texas Instruments](#) Information

## Optimize Your Supply Chain with WIN SOURCE Solutions

-  Global Sourcing Solution
-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management