Jameco Part Number 23915TI

LM148, LM248, LM348
QUADRUPLE OPERATIONAL AMPLIFIERS

- μA741 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)

```
1OUT  [ 1      14 ]  4OUT
1IN−  [ 2      13 ]  4IN−
1 IN+ [ 3      12 ]  4IN+
VCC+  [ 4      11 ]  VCC−
2IN+  [ 5      10 ]  3IN+
2IN−  [ 6       9 ]  3IN−
2OUT  [ 7       8 ]  3OUT
```

LM148 . . . FK PACKAGE
(TOP VIEW)

```
            1IN−  1OUT  NC  4OUT  4IN−
              3    2    1   20   19
1IN+  [ 4                         18 ]  4IN+
NC    [ 5                         17 ]  NC
VCC+  [ 6                         16 ]  VCC−
NC    [ 7                         15 ]  NC
2IN+  [ 8                         14 ]  3IN+
              9   10   11   12   13
            2IN−  2OUT  NC  3OUT  3IN−
```
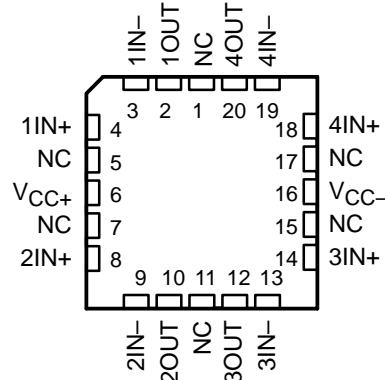
NC – No internal connection

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 μA741. These amplifiers exhibit low supply-current drain and input bias and offset currents that are much less than those of the μA741.

ORDERING INFORMATION

T_A	V_{IO}max 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	
		SOP (NS)	Reel of 2000	LM348NSR	LM348
−25°C to 85°C	6 mV	PDIP (N)	Tube of 25	LM248N	LM248N
		SOIC (D)	Tube of 50	LM248D	LM248
			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, symboliztion, and PCB design guidelines are available at www.ti.com/sc/package.

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TEXAS INSTRUMENTS

symbol (each amplifier)

IN+ ——— +

IN– ——— –

OUT

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, θ_{JA} (see Notes 5 and 6): D package . . . . 86°C/W
N package . . . . 80°C/W
NS package . . . . 76°C/W
Package thermal impedance, θ_{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), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperautre 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), θ_{JC}, and T_C. The maximum allowable power dissipation at any allowable ambient temperautre 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

electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		LM148 MIN	LM148 TYP	LM148 MAX	LM248 MIN	LM248 TYP	LM248 MAX	LM348 MIN	LM348 TYP	LM348 MAX	UNIT
V_{IO}	Input offset voltage	$V_O = 0$	25°C		1	5		1	6		1	6	mV
			Full range			6			7.5			7.5	
I_{IO}	Input offset current	$V_O = 0$	25°C		4	25		4	50		4	50	nA
			Full range			75			125			100	
I_{IB}	Input bias current	$V_O = 0$	25°C		30	100		30	200		30	200	nA
			Full range			325			500			400	
V_{ICR}	Common-mode input voltage range		Full range	±12			±12			±12			V
V_{OM}	Maximum peak output voltage swing	$R_L = 10$ kΩ	25°C	±12	±13		±12	±13		±12	±13		V
		$R_L \geq 10$ kΩ	Full range	±12			±12			±12			
		$R_L = 2$ kΩ	25°C	±10	±12		±10	±12		±10	±12		
		$R_L \geq 2$ kΩ	Full range	±10			±10			±10			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm10$ V, $R_L = \geq 2$ kΩ	25°C	50	160		25	160		25	160		V/mV
			Full range	25			15			15			
r_i	Input resistance‡		25°C	0.8	2.5		0.8	2.5		0.8	2.5		MΩ
B_1	Unity-gain bandwidth	$A_{VD} = 1$	25°C		1			1			1		MHz
ϕ_m	Phase margin	$A_{VD} = 1$	25°C		60°			60°			60°		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}min$, $V_O = 0$	25°C	70	90		70	90		70	90		dB
			Full range	70			70			70			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm9$ V to ±15 V, $V_O = 0$	25°C	77	96		77	96		77	96		dB
			Full range	77			77			77			
I_{OS}	Short-circuit output current		25°C		±25			±25			±25		mA
I_{CC}	Supply current (four amplifiers)	No load, $V_O = 0$	25°C					2.4	4.5		2.4	4.5	mA
		No load, $V_O = V_{OM}$	25°C		2.4	3.6							
V_{O1}/V_{O2}	Crosstalk attenuation	f = 1 Hz to 20 kHz	25°C		120			120			120		dB

† All characteristics are measured under open-loop conditions with zero common-mode input voltage, unless otherwise specified. Full range for T_A is −55°C to 125°C for LM148, −25°C to 85°C for LM248, and 0°C to 70°C for LM348.

‡ This parameter is not production tested.

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

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR Slew rate at unity gain	R_L = 2 kΩ, C_L = 100 pF, See Figure 1		0.5		V/µs

PARAMETER MEASUREMENT INFORMATION
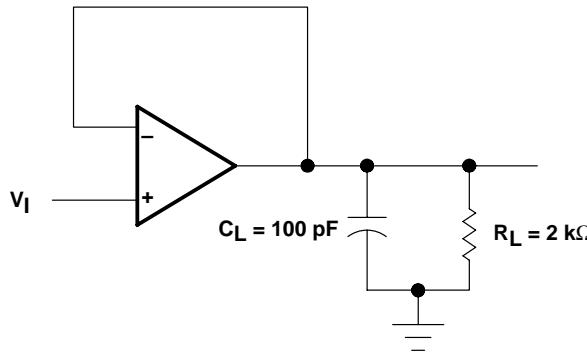
Figure 1. Unity-Gain Amplifier

A_{VD} = −100
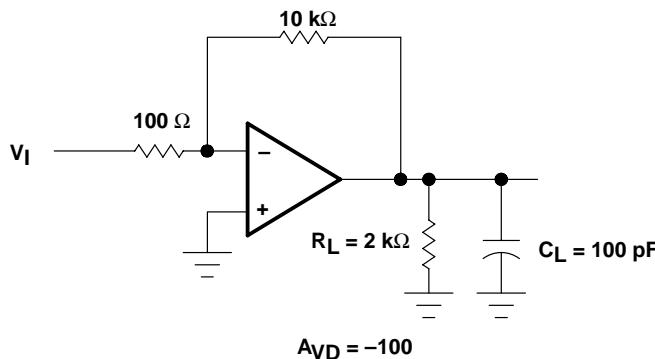
Figure 2. Inverting Amplifier

J (R-GDIP-T**)

CERAMIC DUAL-IN-LINE

14 LEADS SHOWN
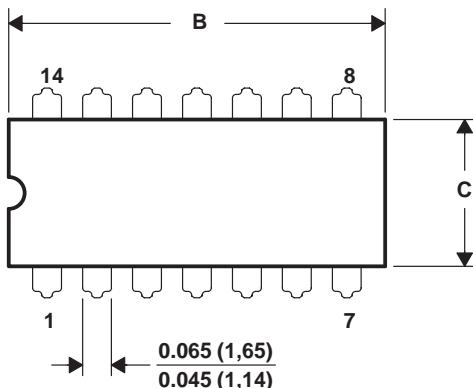
DIM	PINS **	14	16	20
A MAX		0.310 (7,87)	0.310 (7,87)	0.310 (7,87)
A MIN		0.290 (7,37)	0.290 (7,37)	0.290 (7,37)
B MAX		0.785 (19,94)	0.785 (19,94)	0.975 (24,77)
B MIN		0.755 (19,18)	0.755 (19,18)	0.930 (23,62)
C MAX		0.300 (7,62)	0.300 (7,62)	0.300 (7,62)
C MIN		0.245 (6,22)	0.245 (6,22)	0.245 (6,22)

0.065 (1,65) / 0.045 (1,14)

0.100 (2,54) / 0.070 (1,78)

0.020 (0,51) MIN

0.200 (5,08) MAX

Seating Plane

0.130 (3,30) MIN

0.023 (0,58) / 0.015 (0,38)

0.100 (2,54)

A

0°–15°

0.014 (0,36) / 0.008 (0,20)
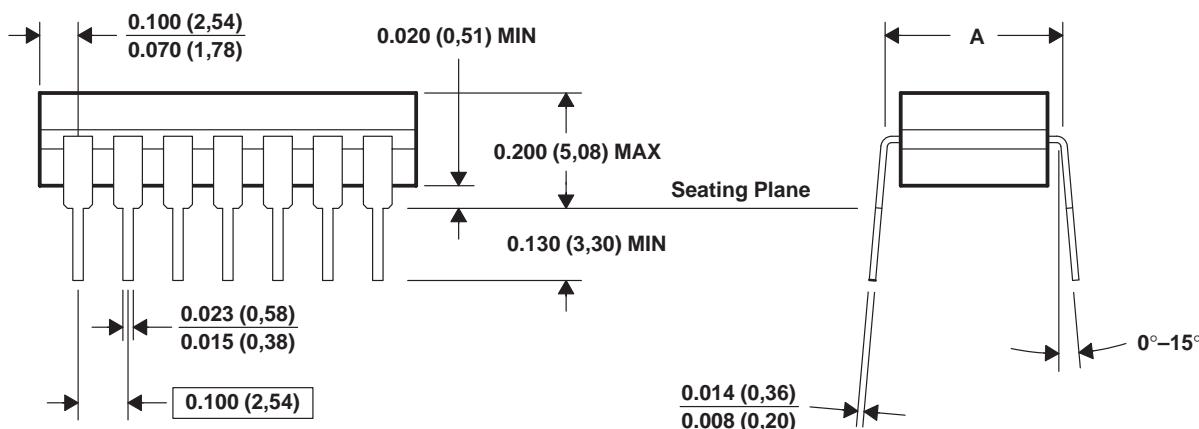
4040083/E 03/99

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.
        E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, and GDIP1-T20

TEXAS INSTRUMENTS

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN
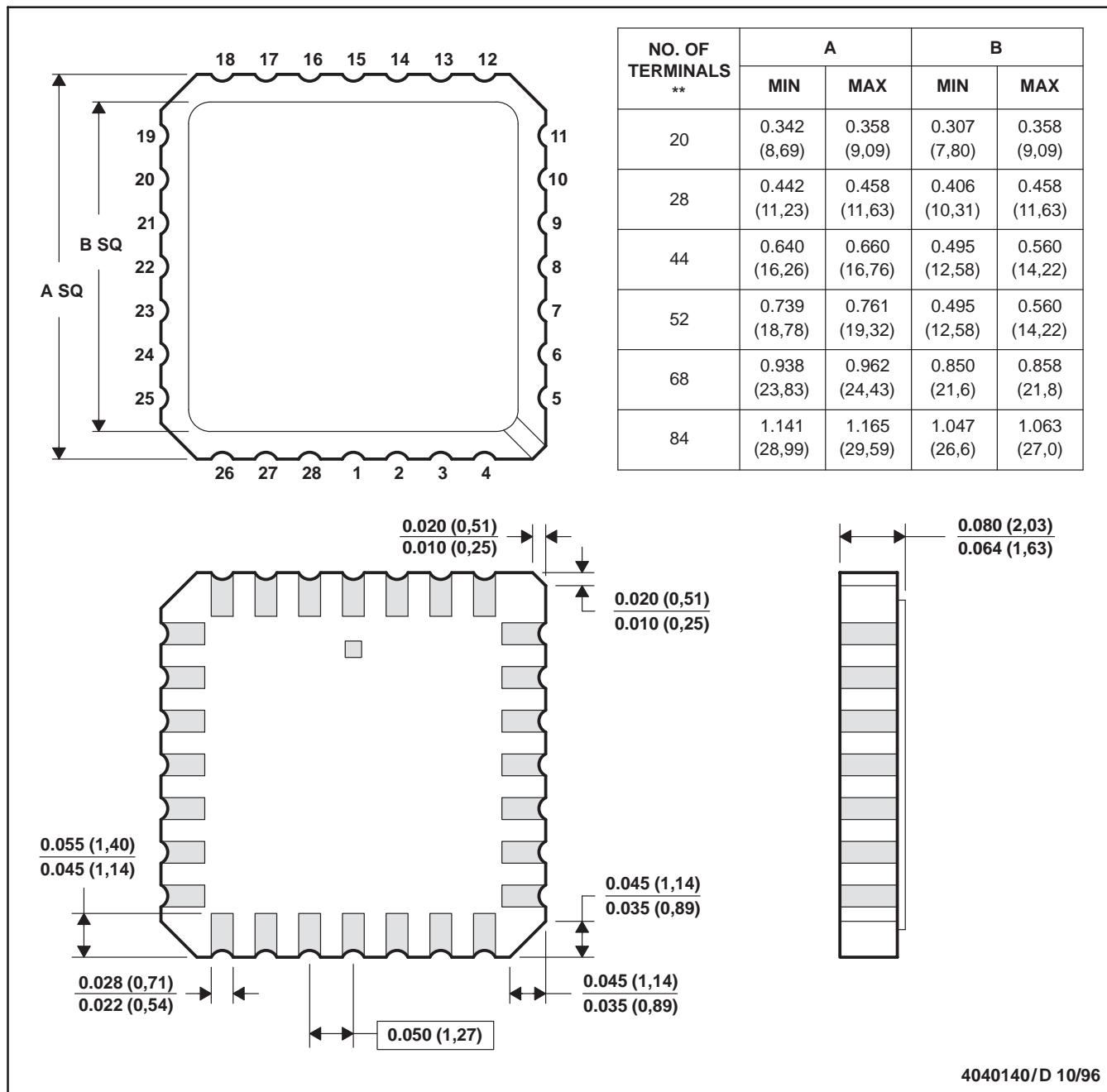
| NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.739 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)

4040140/D 10/96

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

TEXAS INSTRUMENTS

MECHANICAL

N (R-PDIP-T**)   **PLASTIC DUAL-IN-LINE PACKAGE**

16 PINS SHOWN
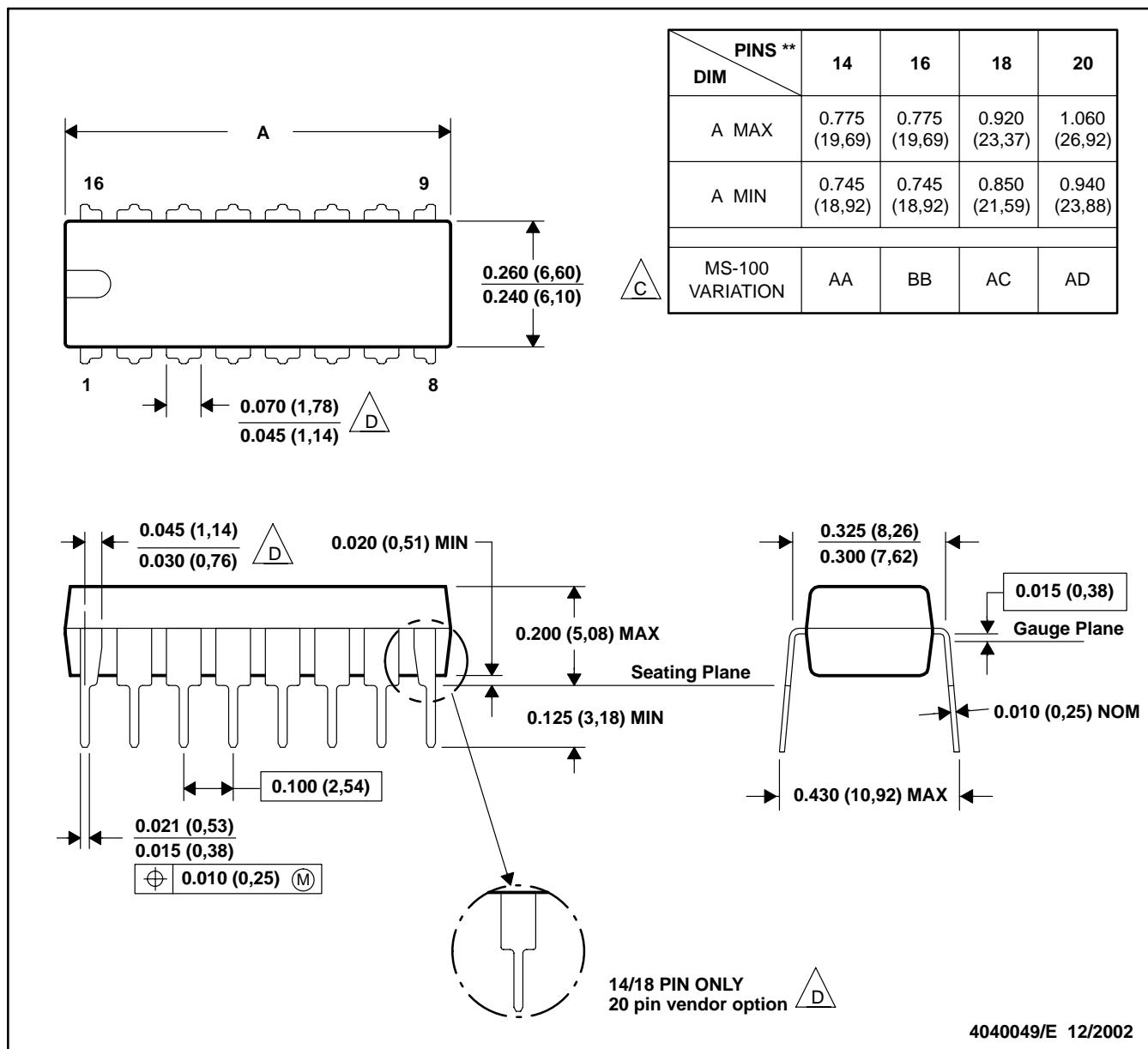
PINS ** DIM	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS-100 VARIATION	AA	BB	AC	AD

0.260 (6,60) / 0.240 (6,10) △C

0.070 (1,78) / 0.045 (1,14) △D

0.045 (1,14) / 0.030 (0,76) △D

0.020 (0,51) MIN

0.200 (5,08) MAX

Seating Plane

0.125 (3,18) MIN

0.100 (2,54)

0.021 (0,53) / 0.015 (0,38)

⊕ 0.010 (0,25) Ⓜ

0.325 (8,26) / 0.300 (7,62)

0.015 (0,38)

Gauge Plane

0.010 (0,25) NOM

0.430 (10,92) MAX

14/18 PIN ONLY
**20 pin vendor option** △D

4040049/E 12/2002

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 lrngth (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
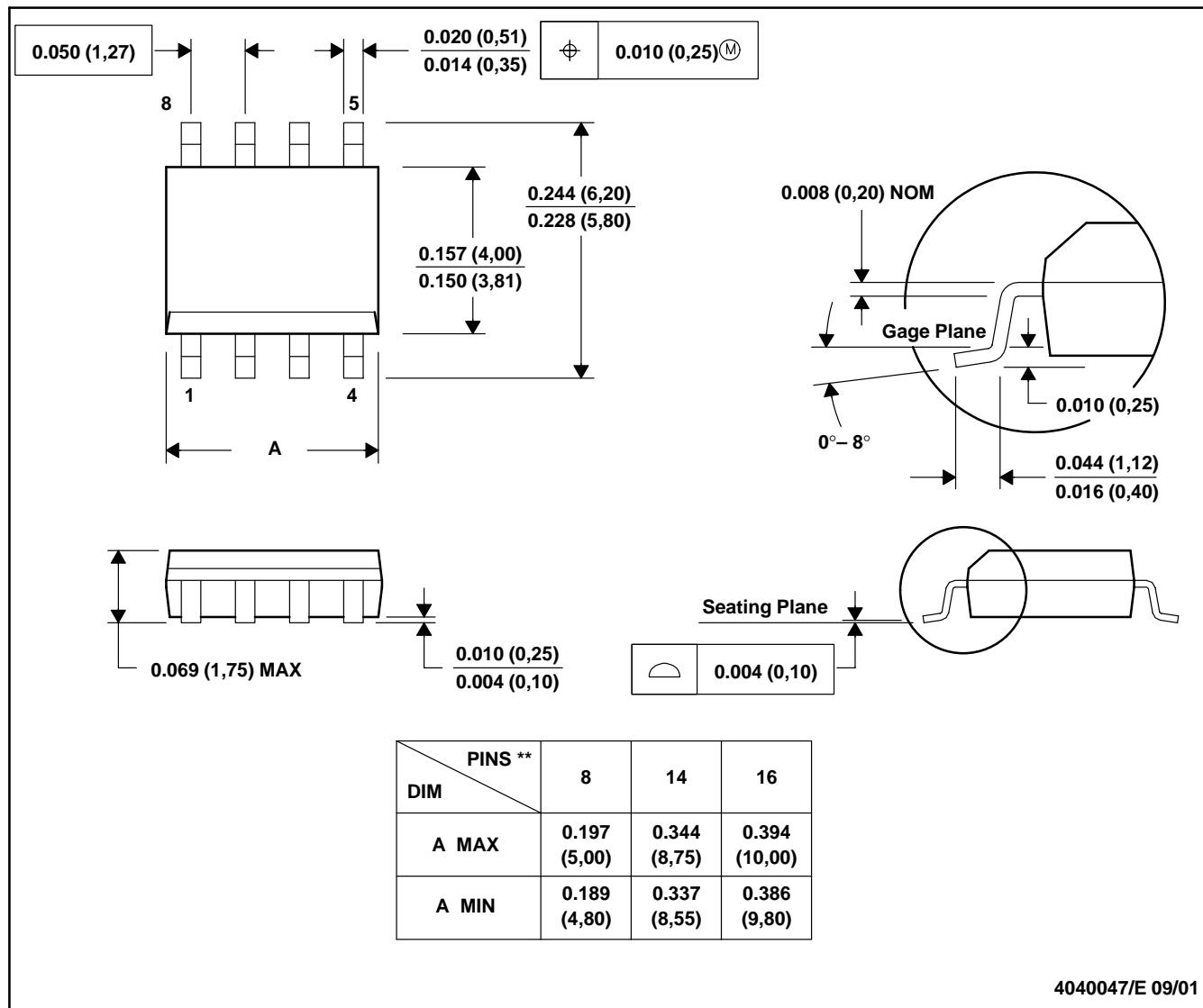
| PINS ** DIM	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

4040047/E 09/01

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

NS (R-PDSO-G**)   **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN

PINS ** DIM	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70
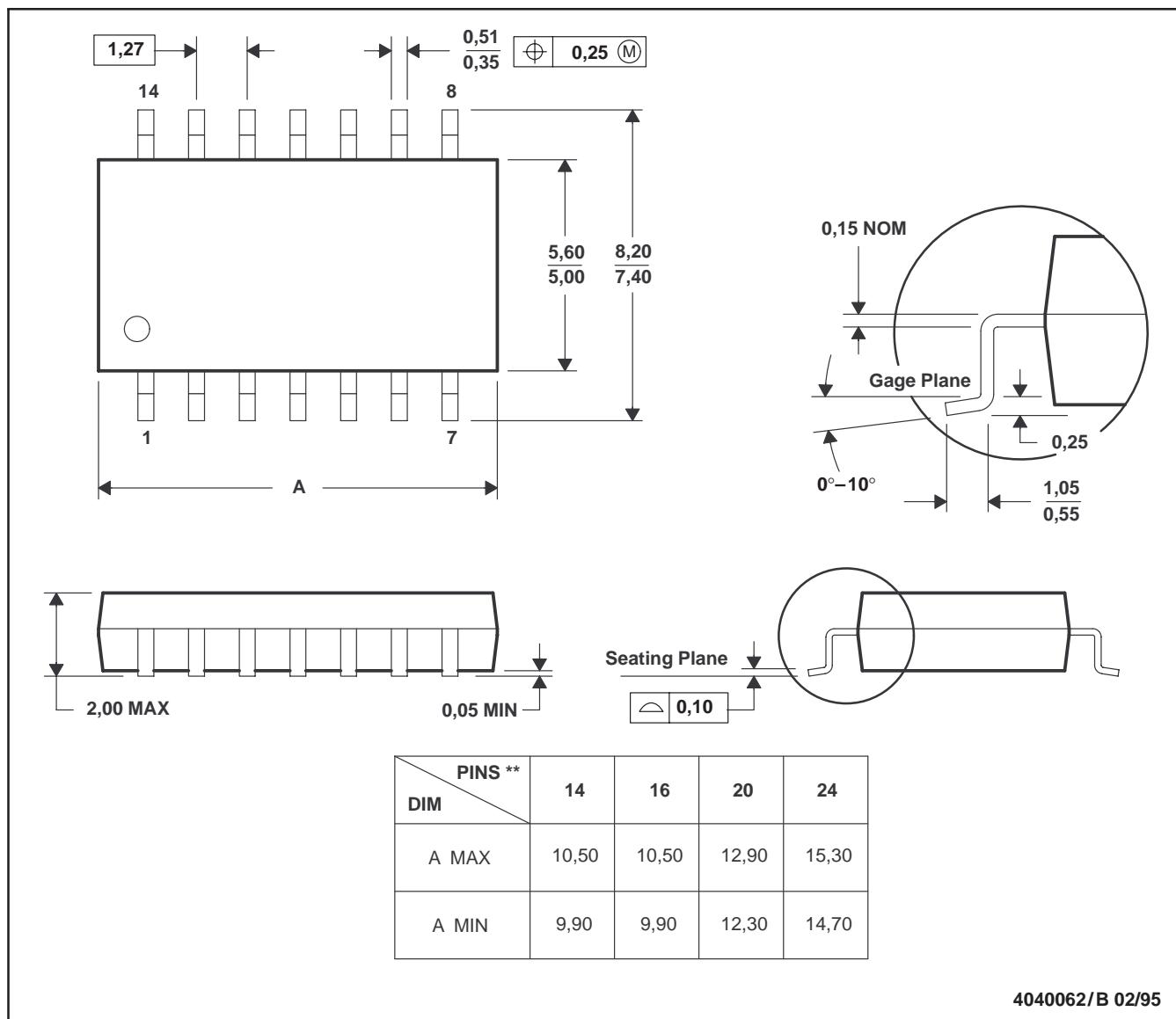
4040062/B 02/95

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.

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