

LM148, LM248, LM348 QUADRUPLE OPERATIONAL AMPLIFIERS

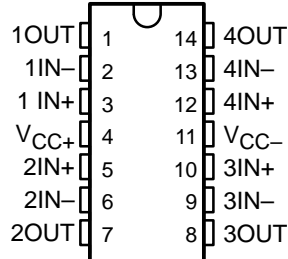
SLOS058C – OCTOBER 1979 – REVISED DECEMBER 2002

- μ 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

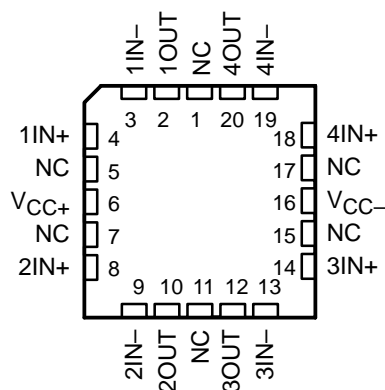
description/ordering information

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

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



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	
		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, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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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**

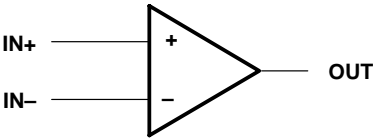
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LM148, LM248, LM348
QUADRUPLE OPERATIONAL AMPLIFIERS

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symbol (each amplifier)



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

Table with 2 columns: Parameter and Rating. Rows include Supply voltage (VCC+), Supply voltage (VCC-), Differential input voltage (VID), Input voltage (VI), Duration of output short circuit, Operating virtual junction temperature (TJ), Package thermal impedance (thetaJA), Package thermal impedance (thetaJC), Case temperature for 60 seconds, Lead temperature, and Storage temperature range.

† 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.

- NOTES: 1. All voltage values, unless otherwise noted, are with respect to the midpoint between VCC+ and VCC-.
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 TJ(max), thetaJA, and TA. The maximum allowable power dissipation at any allowable ambient temperature is PD = (TJ(max) - TA)/thetaJA. Operating at the absolute maximum TJ 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 TJ(max), thetaJC, and TC. The maximum allowable power dissipation at any allowable ambient temperature is PD = (TJ(max) - TC)/thetaJC. Operating at the absolute maximum TJ of 150°C can affect reliability.
8. The package thermal impedance is calculated in accordance with MIL-STD-883.

recommended operating conditions

Table with 4 columns: Parameter, MIN, MAX, UNIT. Rows include Supply voltage (VCC+) and Supply voltage (VCC-).

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

PARAMETER		TEST CONDITIONS†		LM148			LM248			LM348			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
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 ≥ 10 kΩ	Full range	±12			±12			±12			
		R _L = 2 kΩ	25°C	±10		±12	±10		±12	±10		±12	
		R _L ≥ 2 kΩ	Full range	±10			±10			±10			
A _{VD}	Large-signal differential voltage amplification	V _O = ±10 V, R _L = ≥ 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 _{ICRmin} , V _O = 0	25°C	70		90	70		90	70		90	dB
			Full range	70			70			70			
k _{SVR}	Supply-voltage rejection ratio (ΔV _{CC±} /ΔV _{IO})	V _{CC±} = ±9 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
					V _O = V _{OM}	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.

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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		V/ μs

PARAMETER MEASUREMENT INFORMATION

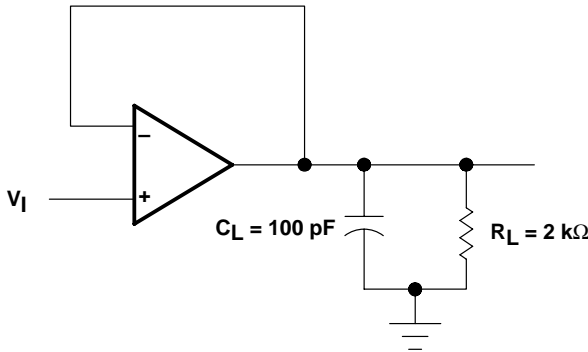


Figure 1. Unity-Gain Amplifier

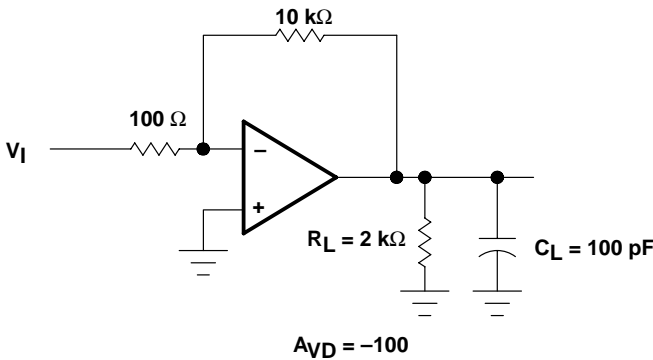
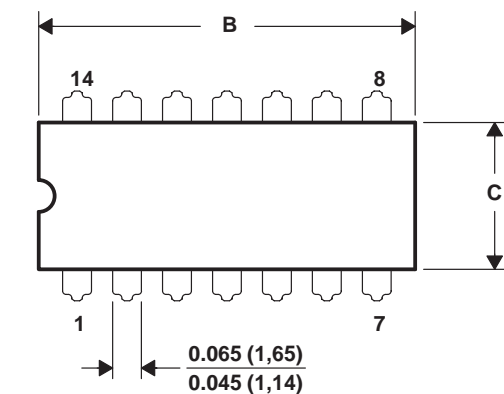


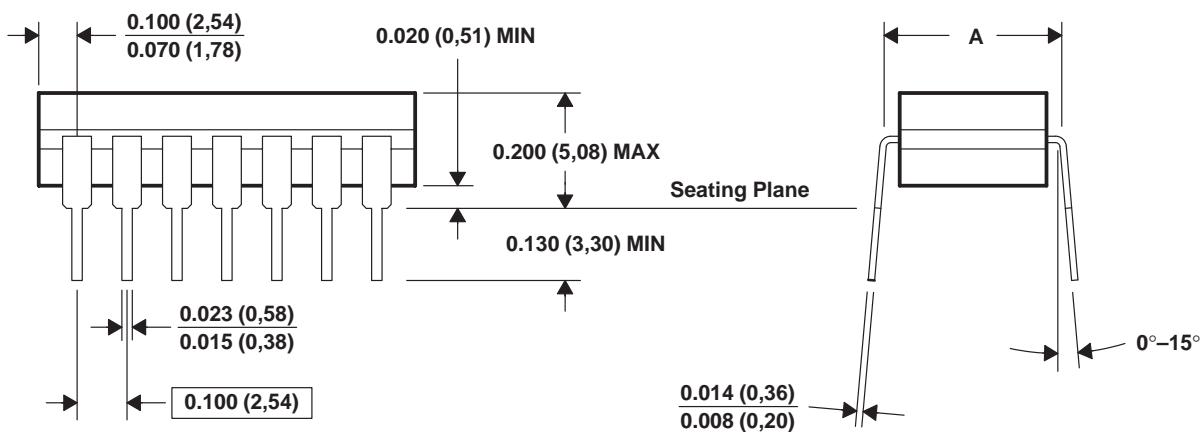
Figure 2. Inverting Amplifier

CERAMIC DUAL-IN-LINE

14 LEADS SHOWN



PINS ** DIM	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)



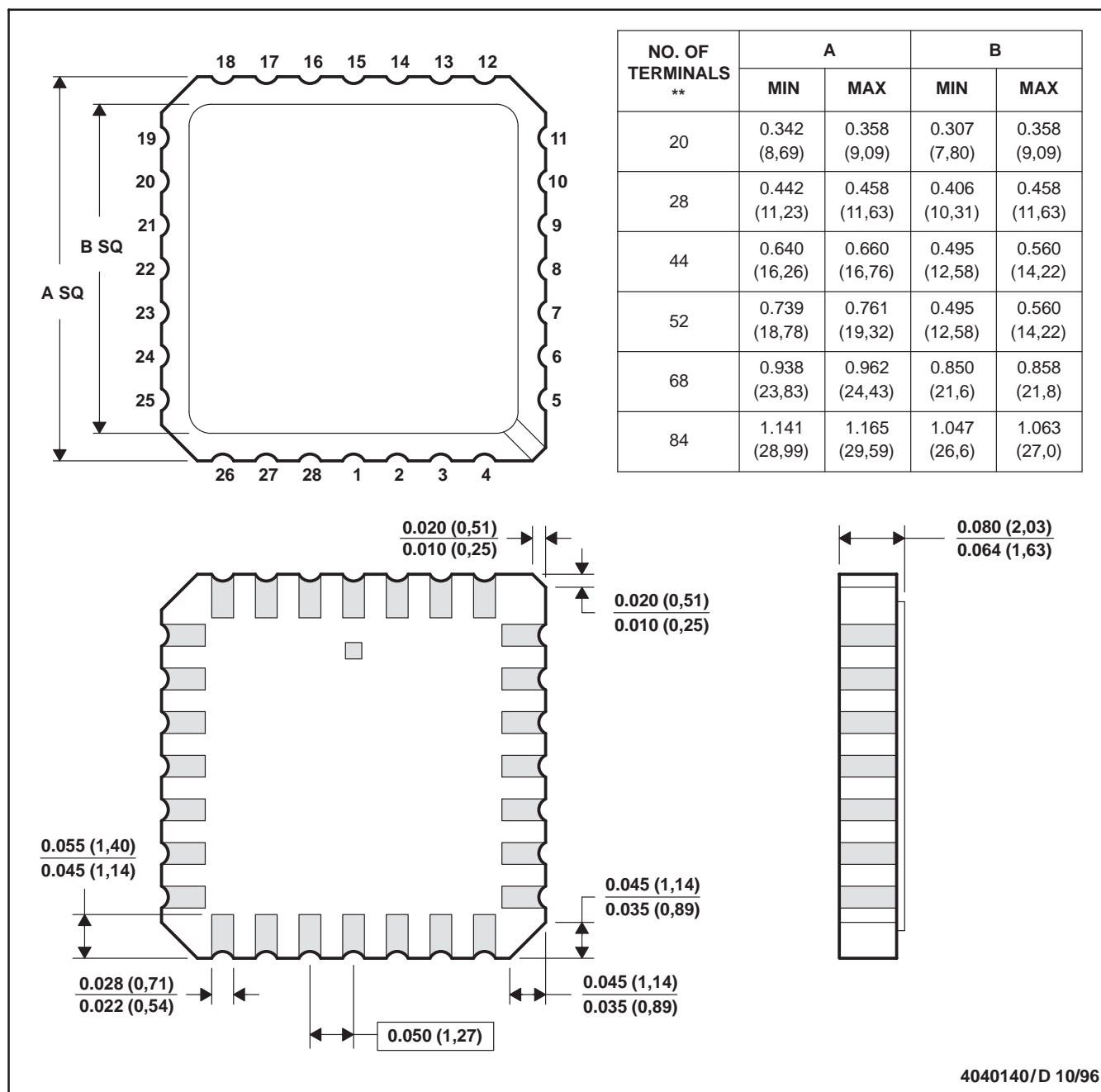
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- NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification.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

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

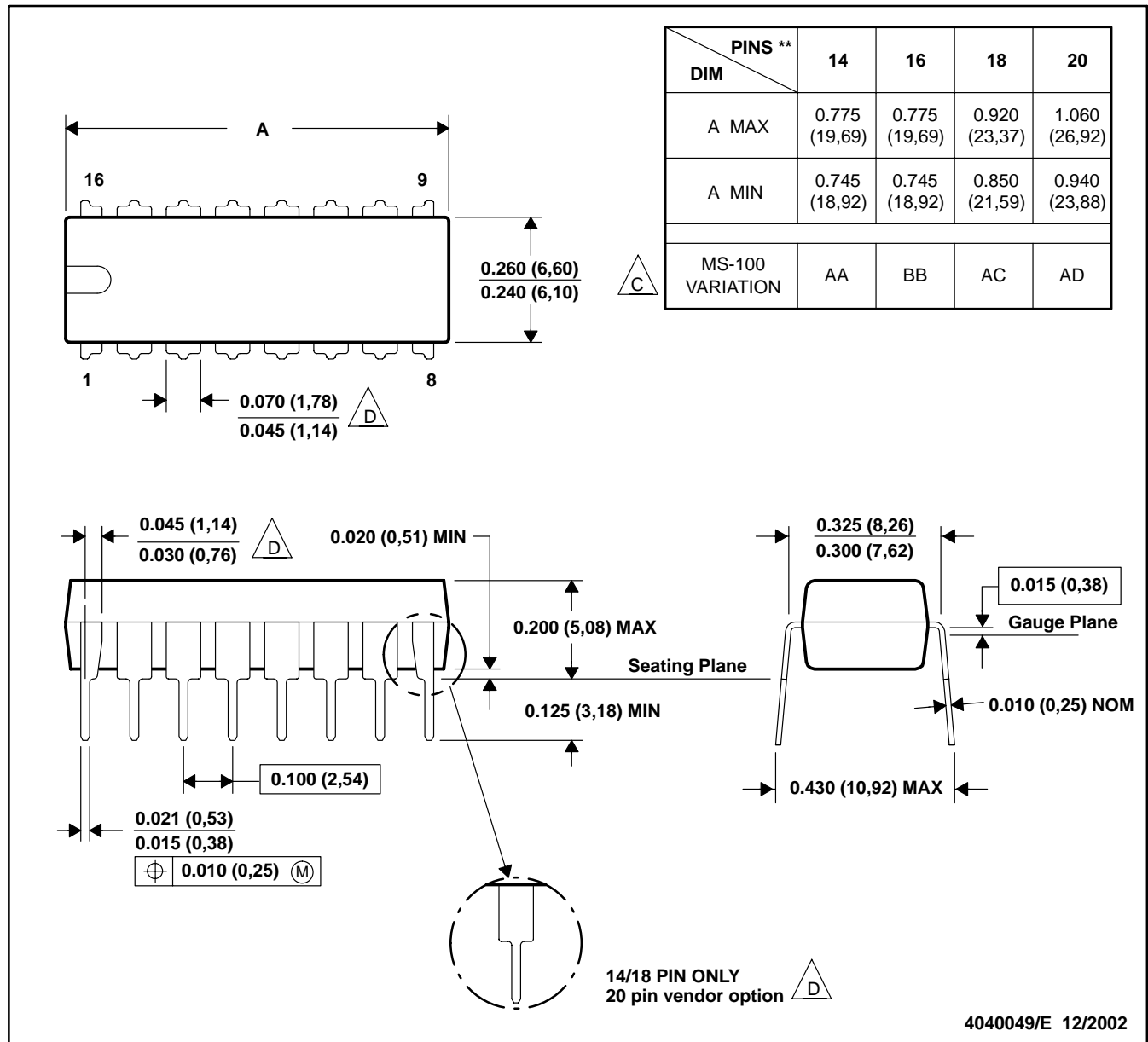
28 TERMINAL SHOWN



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

N (R-PDIP-T)**

16 PINS SHOWN

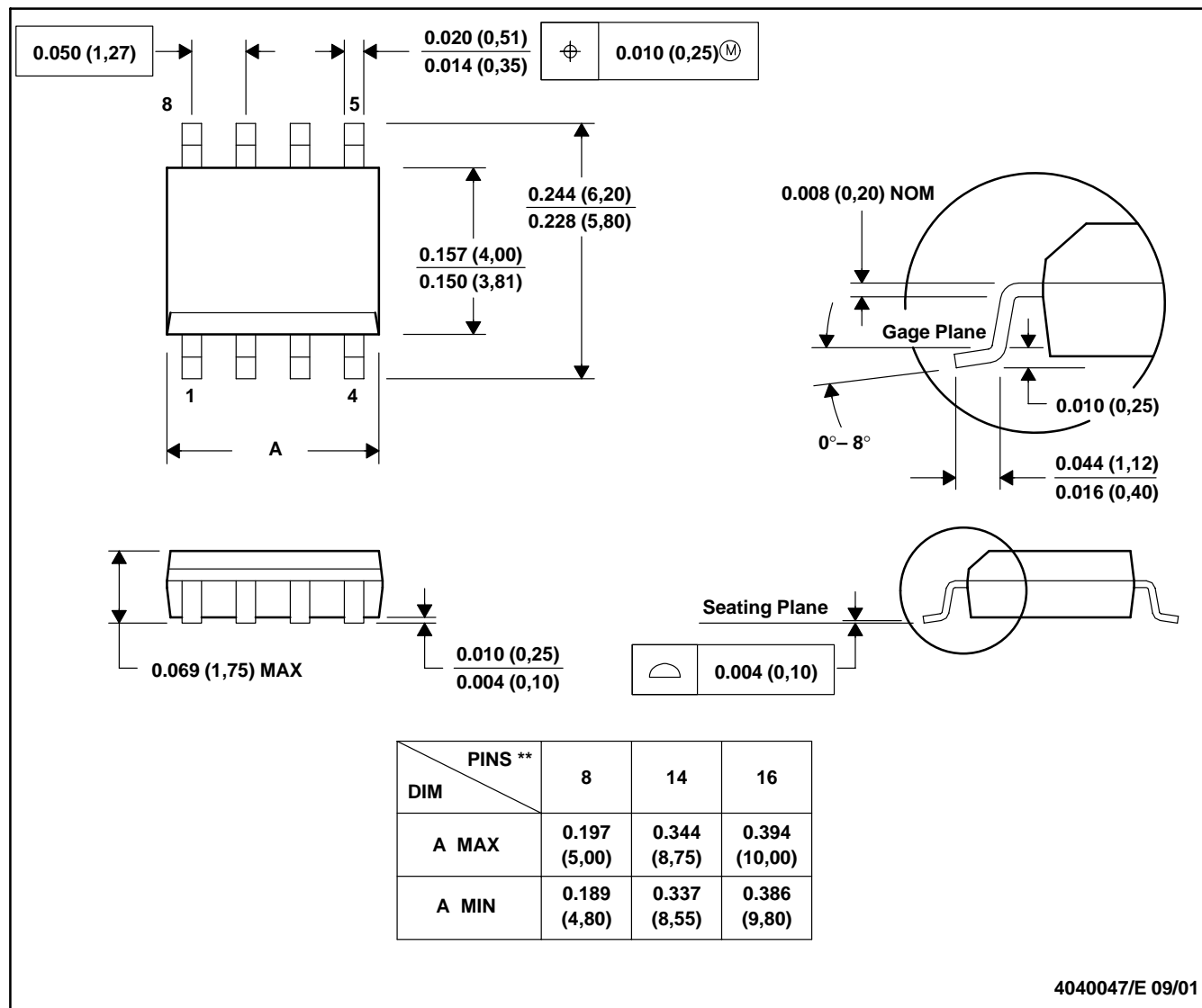
PLASTIC DUAL-IN-LINE PACKAGE

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.

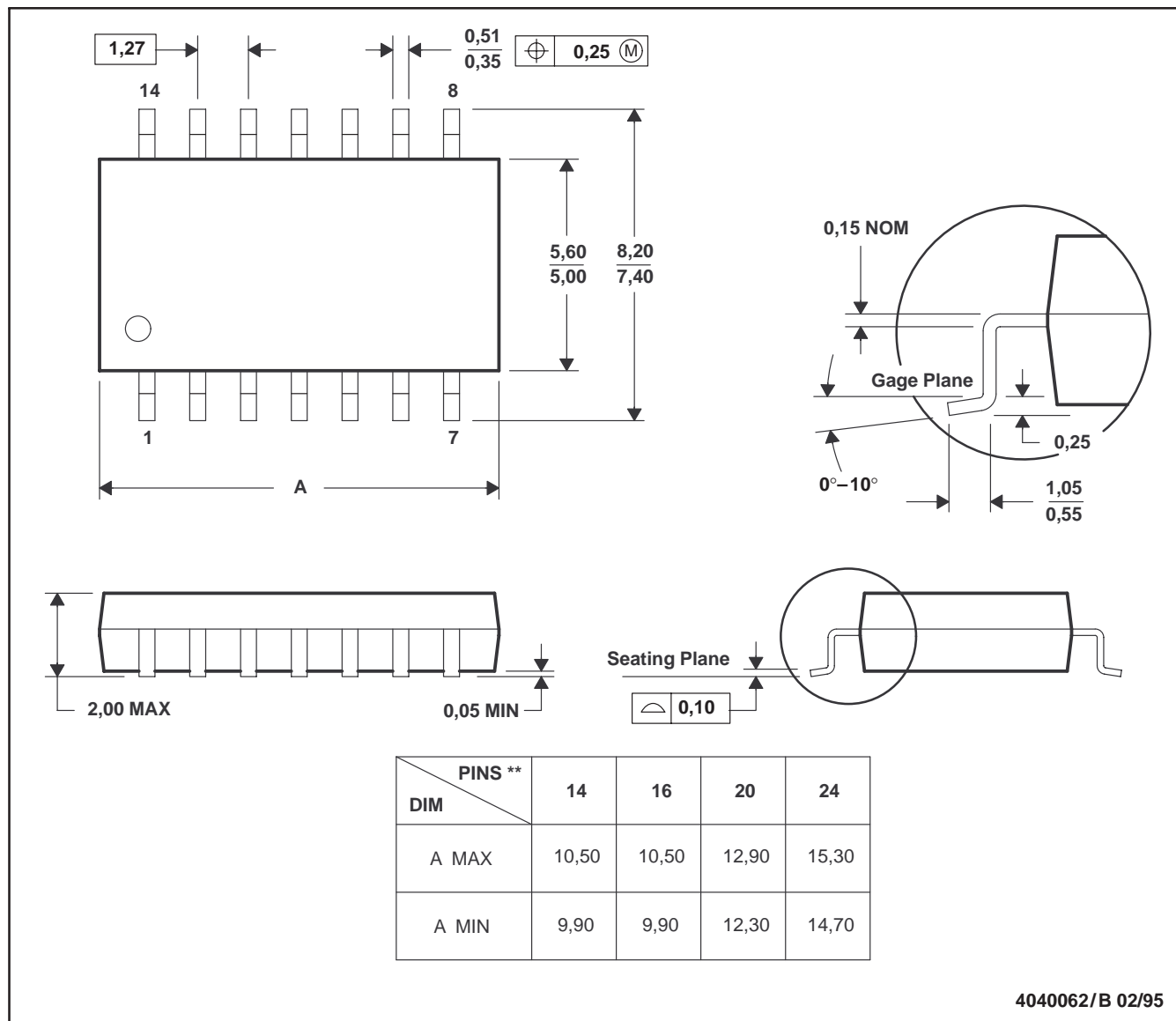
D (R-PDSO-G)****PLASTIC SMALL-OUTLINE PACKAGE****8 PINS SHOWN**

- 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

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.

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