

# CD4048B Types

## CMOS Multifunction Expandable 8-Input Gate

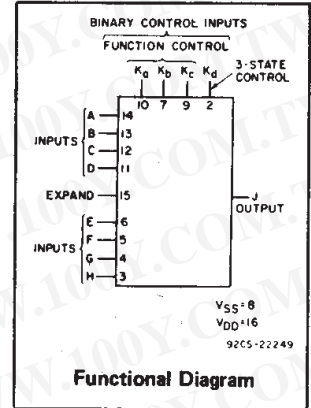
High-Voltage Types (20-Volt Rating)

■ CD4048B is an 8-input gate having four control inputs. Three binary control inputs – Ka, Kb, and Kc – provide the implementation of eight different logic functions. These functions are OR, NOR, AND, NAND, OR/AND, OR/NAND, AND/OR and AND/NOR.

A fourth control input, Kd, provides the user with a 3-state output. When control input Kd is high, the output is either a logic 1 or a logic 0 depending on the inner states. When control input Kd is low, the output is an open circuit. This feature enables the user to connect this device to a common bus line.

In addition to the eight input lines, an EXPAND input is provided that permits the user to increase the number of inputs into a CD4048B (see Fig. 2). For example, two CD4048Bs can be cascaded to provide a 16-input multifunction gate. When the EXPAND input is not used, it should be connected to V<sub>SS</sub>.

The CD4048B-series types are supplied in 16-lead hermetic dual-in-line ceramic packages (F3A suffix), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline packages (M, M96, MT, and NSR suffixes), and 16-lead thin shrink small-outline packages (PW and PWR suffixes).



**MAXIMUM RATINGS, Absolute-Maximum Values:**

DC SUPPLY-VOLTAGE RANGE, (V <sub>DD</sub> )	-0.5V to +20V
Voltages referenced to V <sub>SS</sub> Terminal)	
INPUT VOLTAGE RANGE, ALL INPUTS	-0.5V to V <sub>DD</sub> +0.5V
DC INPUT CURRENT, ANY ONE INPUT	±10mA
POWER DISSIPATION PER PACKAGE (P <sub>D</sub> ):	
For T <sub>A</sub> = -55°C to +100°C	500mW
For T <sub>A</sub> = +100°C to +125°C	Derate Linearly at 12mW/°C to 200mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR	
FOR T <sub>A</sub> = FULL PACKAGE-TEMPERATURE RANGE (All Package Types)	100mW
OPERATING-TEMPERATURE RANGE (T <sub>A</sub> )	-55°C to +125°C
STORAGE TEMPERATURE RANGE (T <sub>sig</sub> )	-65°C to +150°C
LEAD TEMPERATURE (DURING SOLDERING):	
At distance 1/16 ± 1/32 inch (1.59 ± 0.79mm) from case for 10s max	+285°C

**Features:**

- Three-state output
- Many logic functions available in one package
- Standardized, symmetrical output characteristics
- 100% tested for quiescent current at 20 V
- Maximum input current of 1 μA at 18 V (full package-temperature range), 100 nA at 18 V and 25°C
- Noise margin (full package-temperature range) = 1 V at V<sub>DD</sub>=5 V, 2 V at V<sub>DD</sub> = 10 V, 2.5 V at V<sub>DD</sub>=15 V
- 5-V, 10-V, and 15-V parametric ratings
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

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**Applications:**

- Selection of up to 8 logic functions
- Digital control of logic
- General-purpose gating logic
  - Decoding
  - Encoding

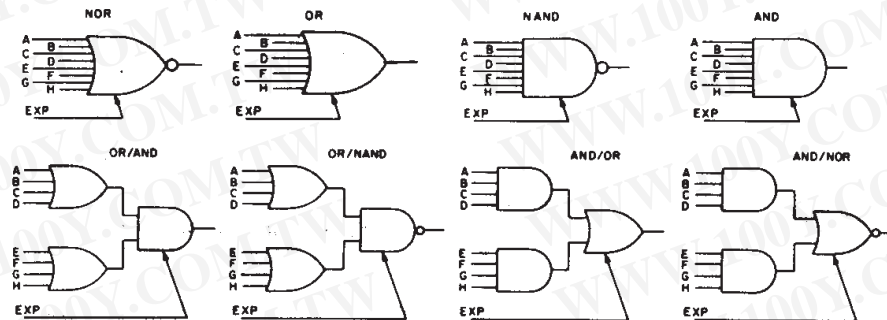
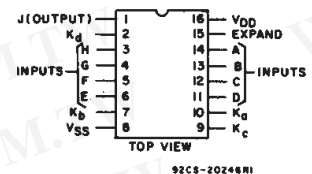


Fig. 1 - Basic logic configurations.



**TERMINAL ASSIGNMENT**

**RECOMMENDED OPERATING CONDITIONS**

For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

CHARACTERISTIC	LIMITS		UNITS
	MIN.	MAX.	
Supply-Voltage Range (For T <sub>A</sub> = Full Package Temperature Range)	3	18	V

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### CD4048B Types

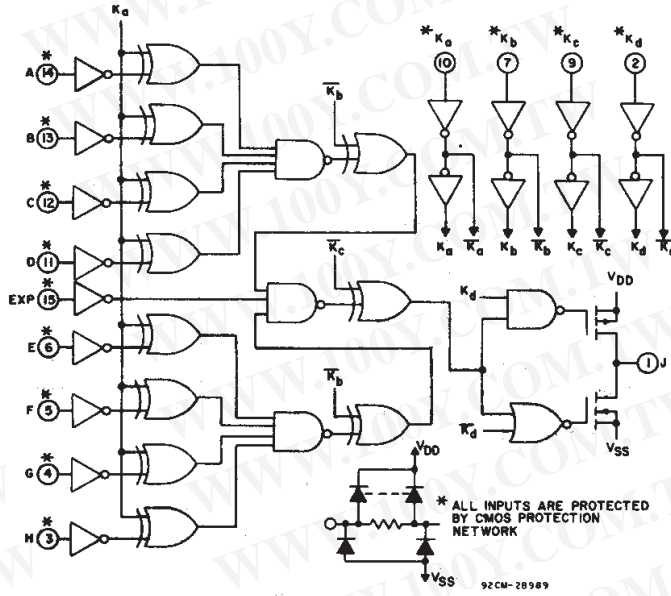


Fig. 2 - Logic diagram.

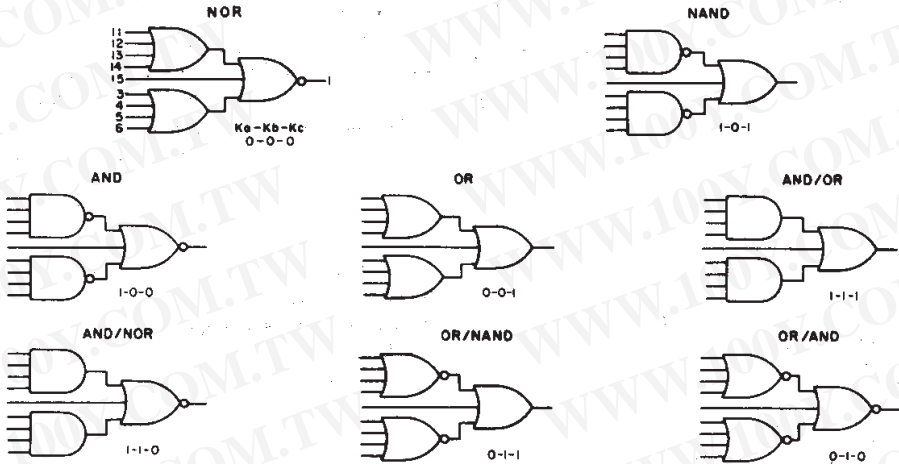


Fig. 3 - Actual-circuit logic configurations.

#### APPLICATIONS OF EXPAND INPUT

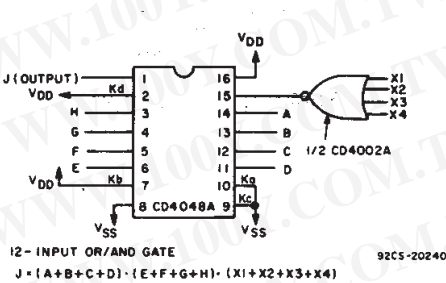


Fig. 4 - 12-input OR/AND gate.

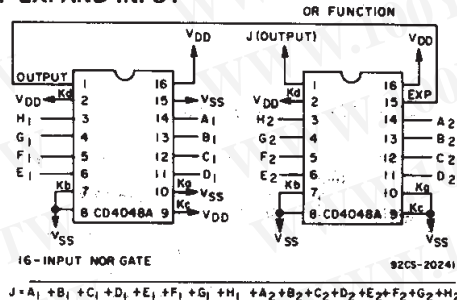


Fig. 5 - 16-input NOR gate.

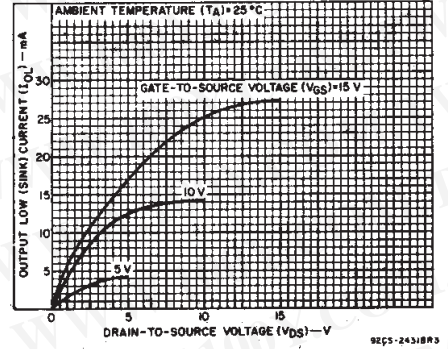


Fig. 6 - Typical output low (sink) current characteristics.

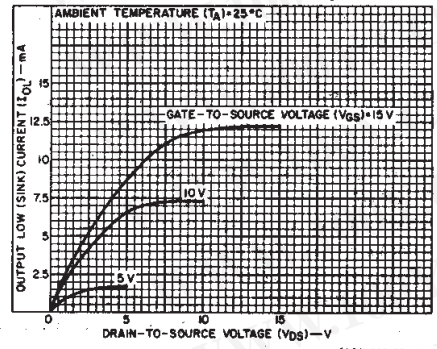


Fig. 7 - Minimum output low (sink) current characteristics.

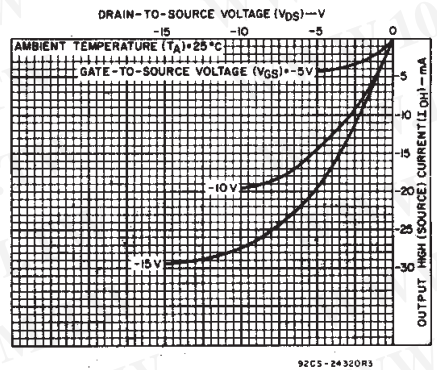


Fig. 8 - Typical output high (source) current characteristics.

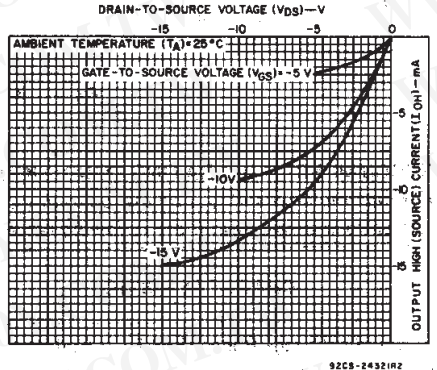


Fig. 9 - Minimum output high (source) current characteristics.

# CD4048B Types

## STATIC ELECTRICAL CHARACTERISTICS

CHARACTER- ISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	VO (V)	VIN (V)	VDD (V)	+25							
				-55	-40	+85	+125	Min.	Typ.	Max.	
Quiescent Device Current, IDD Max.	-	0,5	5	0.25	0.25	7.5	7.5	-	0.01	0.25	μA
	-	0,10	10	0.5	0.5	15	15	-	0.01	0.5	
	-	0,15	15	1	1	30	30	-	0.01	1	
	-	0,20	20	5	5	150	150	-	0.02	5	
Output Low (Sink) Current IOL Min.	0.4	0,5	5	0.64	0.61	0.42	0.36	0.51	1	-	mA
	0.5	0,10	10	1.6	1.5	1.1	0.9	1.3	2.6	-	
	1.5	0,15	15	4.2	4	2.8	2.4	3.4	6.8	-	
Output High (Source) Current, IOH Min.	4.6	0,5	5	-0.64	-0.61	-0.42	-0.36	-0.51	-1	-	mA
	2.5	0,5	5	-2	-1.8	-1.3	-1.15	-1.6	-3.2	-	
	9.5	0,10	10	-1.6	-1.5	-1.1	-0.9	-1.3	-2.6	-	
	13.5	0,15	15	-4.2	-4	-2.8	-2.4	-3.4	-6.8	-	
Output Voltage: Low-Level, VOL Max.	-	0,5	5	0.05			-	0	0.05	-	V
	-	0,10	10	0.05			-	0	0.05	-	
	-	0,15	15	0.05			-	0	0.05	-	
Output Voltage: High-Level, VOH Min.	-	0,5	5	4.95			4.95	5	-	-	V
	-	0,10	10	9.95			9.95	10	-	-	
	-	0,15	15	14.95			14.95	15	-	-	
Input Low Voltage, VIL Max.	0.5,4.5	-	5	1.5			-	-	1.5	-	V
	1,9	-	10	3			-	-	3	-	
	1.5,13.5	-	15	4			-	-	4	-	
Input High Voltage, VIH Min.	0.5,4.5	-	5	3.5			3.5	-	-	-	V
	1,9	-	10	7			7	-	-	-	
	1.5,13.5	-	15	11			11	-	-	-	
Input Current IIN Max.		0,18	18	±0.1	±0.1	±1	±1	-	±10 <sup>-5</sup>	±0.1	μA
3-State Output Current, IOUT	0,18	0,18	18	±0.4	±0.4	±12	±12	-	±10 <sup>-4</sup>	±0.4	μA

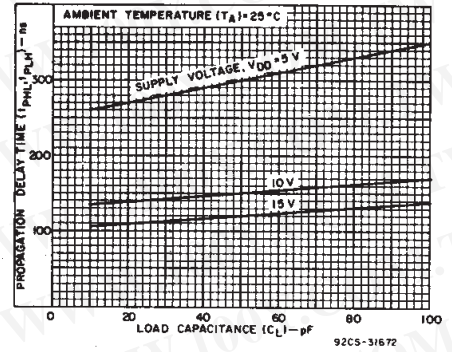


Fig. 10 - Typical propagation delay time (logic inputs to output) as a function of load capacitance.

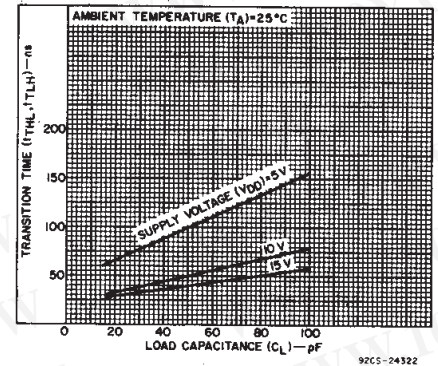


Fig. 11 - Typical transition time vs. load capacitance.

## IMPLEMENTATION OF EXPAND INPUT FOR 9 OR MORE INPUTS

OUTPUT FUNCTION	FUNCTION NEEDED AT EXPAND INPUT	OUTPUT BOOLEAN EXPRESSION
NOR	OR	$J = (A+B+C+D+E+F+G+H) + (\text{EXP})$
OR	OR	$J = (A+B+C+D+E+F+G+H) + (\text{EXP})$
AND	NAND	$J = (ABCDEFHG) \cdot (\text{EXP})$
NAND	NAND	$J = (ABCDEFHG) \cdot (\text{EXP})$
OR/AND	NOR	$J = (A+B+C+D) \cdot (E+F+G+H) \cdot (\text{EXP})$
OR/NAND	NOR	$J = (A+B+C+D) \cdot (E+F+G+H) \cdot (\text{EXP})$
AND/NOR	AND	$J = (ABCD) + (EFGH) + (\text{EXP})$
AND/OR	AND	$J = (ABCD) + (EFGH) + (\text{EXP})$

Note: (EXP) designates the EXPAND function (i.e.,  $X_1 + X_2 + \dots + X_N$ ).

### NOTE:

Refer to FUNCTION TRUTH TABLE for connection of unused inputs.

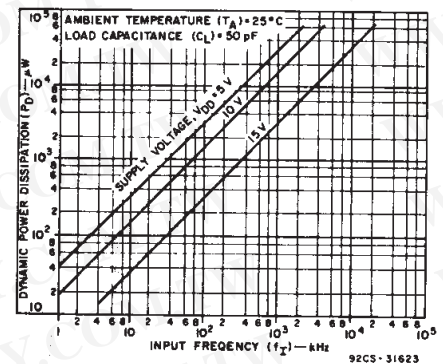


Fig. 12 - Typical power dissipation as a function of input frequency.

## CD4048B Types

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**DYNAMIC CHARACTERISTICS** at  $T_A=25^\circ\text{C}$ ,  $C_L=50\text{ pF}$ , Input  $t_r, t_f=20\text{ ns}$ ,  $R_L=200\text{ k}\Omega$  unless otherwise specified

CHARACTERISTIC	TEST CONDITIONS		LIMITS		UNITS
	$V_{DD}$	V	All Package Types		
			Typ.	Max.	
Propagation Delay: $t_{PHL}, t_{PLH}$ Inputs to Output and Ka to Output	5	5	300	600	ns
	10	10	150	300	
	15	15	120	240	
Kb to Output	5	5	225	450	
	10	10	85	170	
	15	15	55	110	
Kc to Output	5	5	140	280	
	10	10	50	100	
	15	15	40	80	
Expand Input to Output	5	5	190	380	
	10	10	90	180	
	15	15	65	130	
3-State Propagation Delay: Kd to Output $t_{PHZ}, t_{PLZ}$ $t_{PZH}, t_{PZL}$	$R_L=1\text{ k}\Omega$ See Fig.21	5	80	160	
		10	35	70	
		15	25	50	
Transition Time: $t_{THL}, t_{TLH}$		5	100	200	
		10	50	100	
		15	40	80	
Input Capacitance: $C_i$	Any Input		5	7	pF
3-State Output Capacitance			5	10	

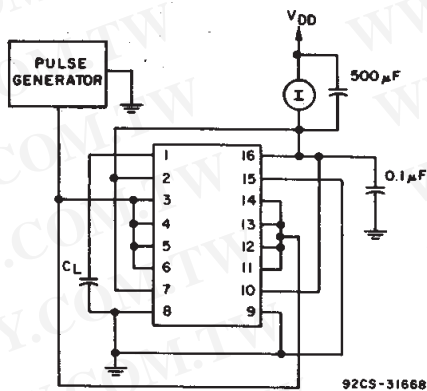


Fig. 13 – Dynamic power dissipation test circuit.

### FUNCTION TRUTH TABLE

OUTPUT FUNCTION	BOOLEAN EXPRESSION	$K_a$	$K_b$	$K_c$	UNUSED INPUT*
NOR	$J = \overline{A+B+C+D+E+F+G+H}$	0	0	0	$V_{SS}$
OR	$J = A+B+C+D+E+F+G+H$	0	0	1	$V_{SS}$
OR/AND	$J = (A+B+C+D) \cdot (E+F+G+H)$	0	1	0	$V_{SS}$
OR/NAND	$J = (A+B+C+D) \cdot \overline{(E+F+G+H)}$	0	1	1	$V_{SS}$
AND	$J = ABCDEFGH$	1	0	0	$V_{DD}$
NAND	$J = \overline{ABCDEFGH}$	1	0	1	$V_{DD}$
AND/NOR	$J = \overline{ABCD+EFGH}$	1	1	0	$V_{DD}$
AND/OR	$J = \overline{ABCD} + EFGH$	1	1	1	$V_{DD}$
$K_d=1$ Normal Inverter Action					
$K_d=0$ High Impedance Output					

EXPAND Input=0

\* See Figs. 1,2,3,4, and 5.

### TEST CIRCUITS - STATIC MEASUREMENTS

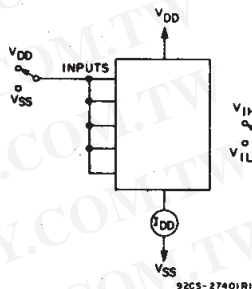


Fig. 14 – Quiescent device current test circuit.

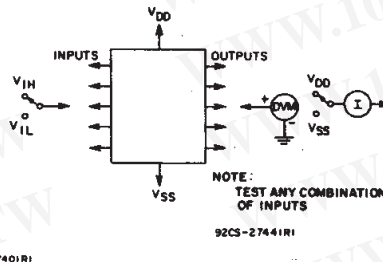


Fig. 15 – Input voltage test circuit.

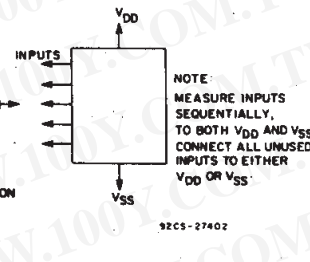


Fig. 16 – Input current test circuit.

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## TEST CIRCUITS - DYNAMIC MEASUREMENTS

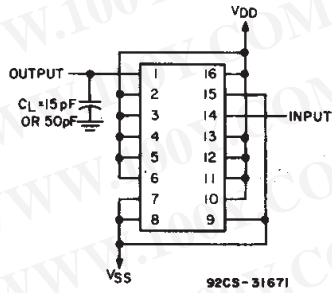


Fig. 17 - Test circuit for  $t_{PHL}$ ,  $t_{THL}$ , and  $t_{TLH}$  (AND) measurements.

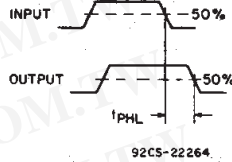


Fig. 18 - Waveforms for  $t_{PHL}$  and  $t_{PHL}$  (AND).

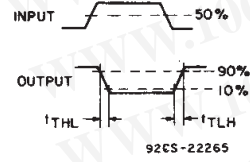


Fig. 19 - Waveforms for  $t_{THL}$  and  $t_{TLH}$  (AND).

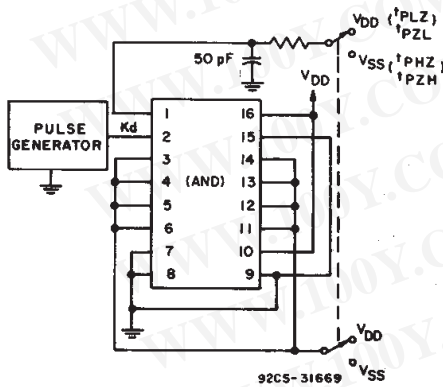


Fig. 20 - Test circuit for  $t_{PZL}$ ,  $t_{PZH}$ ,  $t_{PLZ}$ , and  $t_{PHZ}$  (AND).

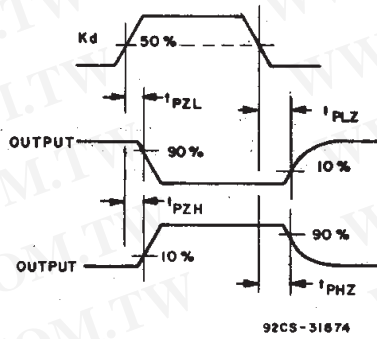
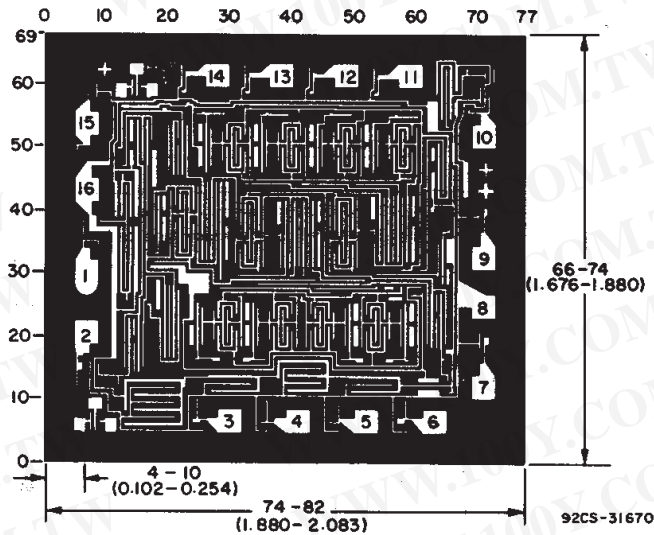


Fig. 21 - Waveforms for  $t_{PZL}$ ,  $t_{PZH}$ ,  $t_{PLZ}$ , and  $t_{PHZ}$  (AND).



Dimensions and pad layout for CD4048BH.

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils ( $10^{-3}$  inch).

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PACKAGING INFORMATION

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
CD4048BE	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD4048BF3A	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
CD4048BM	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4048BM96	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4048BMT	ACTIVE	SOIC	D	16	250	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4048BNSR	ACTIVE	SO	NS	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
CD4048BPW	ACTIVE	TSSOP	PW	16	90	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
CD4048BPWR	ACTIVE	TSSOP	PW	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**None:** Not yet available Lead (Pb-Free).

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

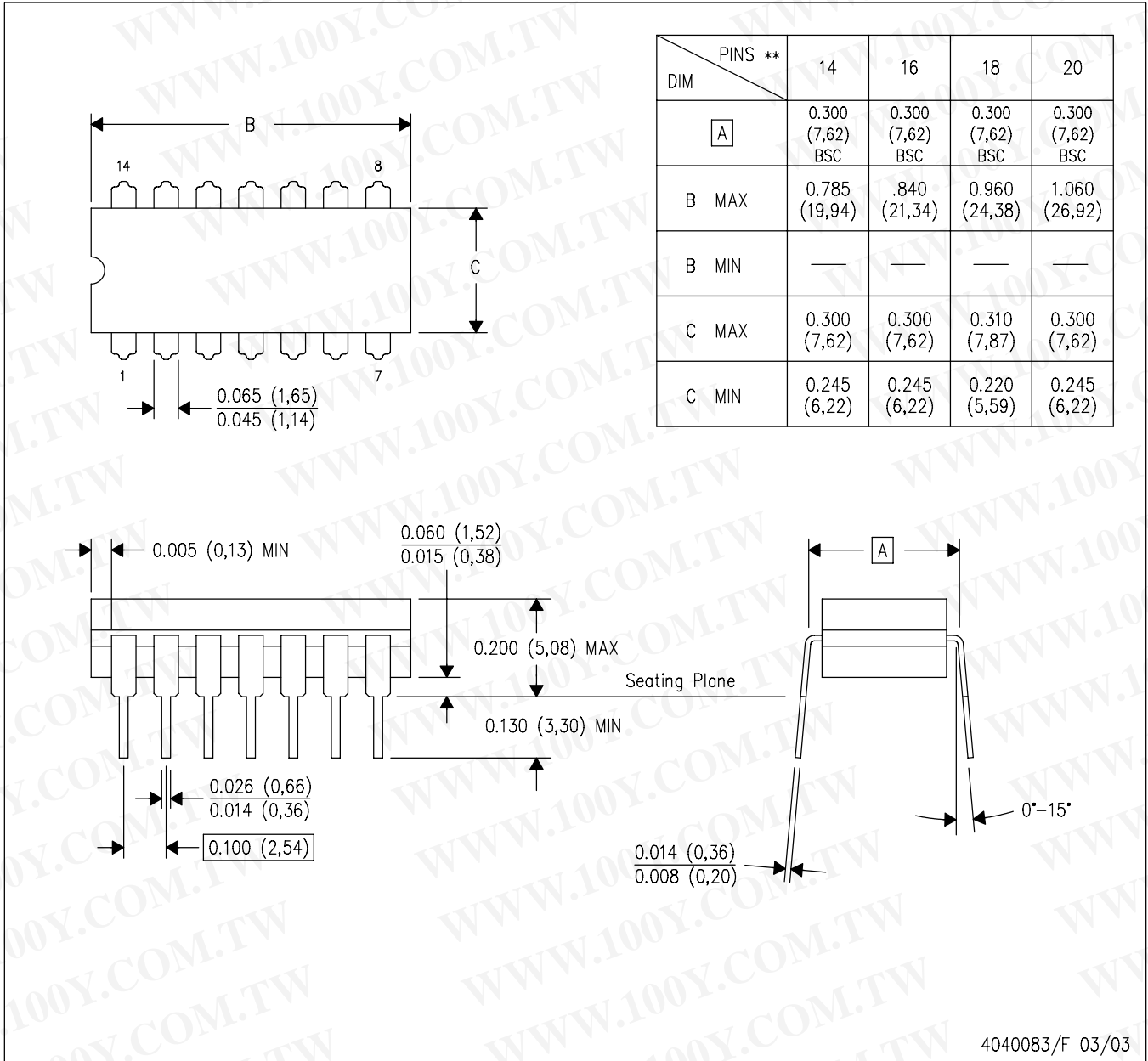
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J (R-GDIP-T\*\*)  
 14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



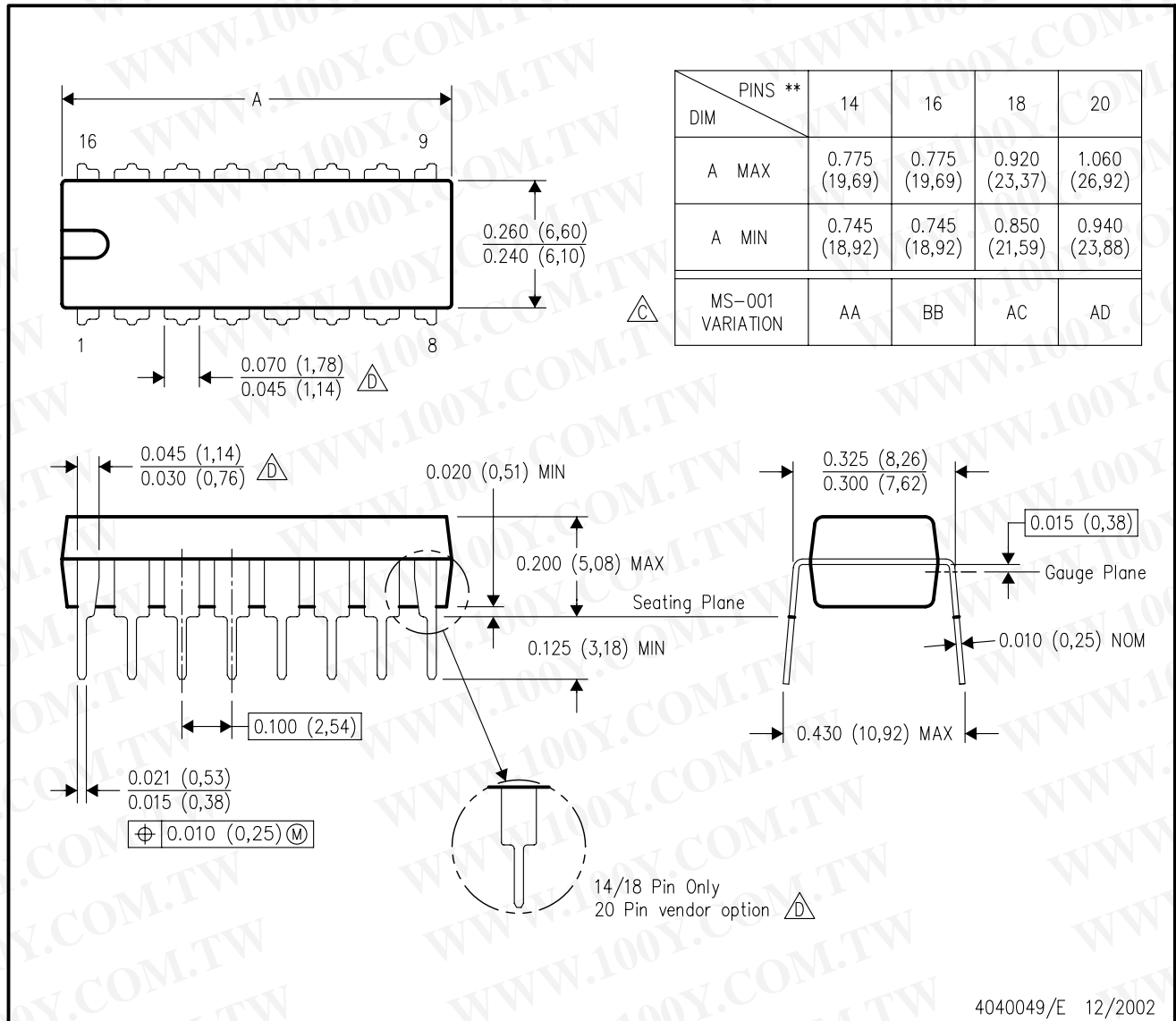
- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package is hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
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

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

16 PINS SHOWN

PLASTIC DUAL-IN-LINE PACKAGE

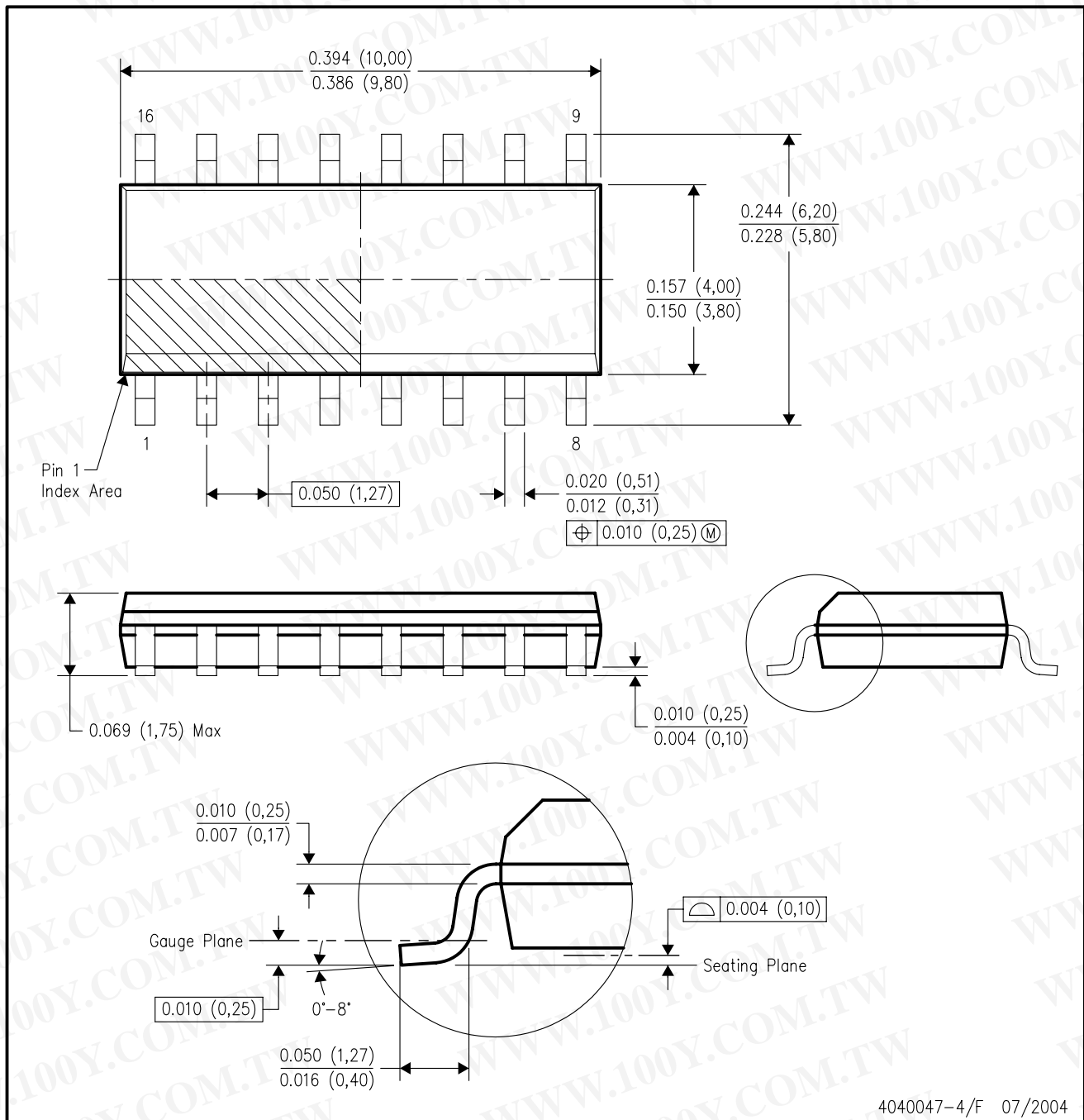


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - D The 20 pin end lead shoulder width is a vendor option, either half or full width.

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D (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



4040047-4/F 07/2004

- 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 variation AC.

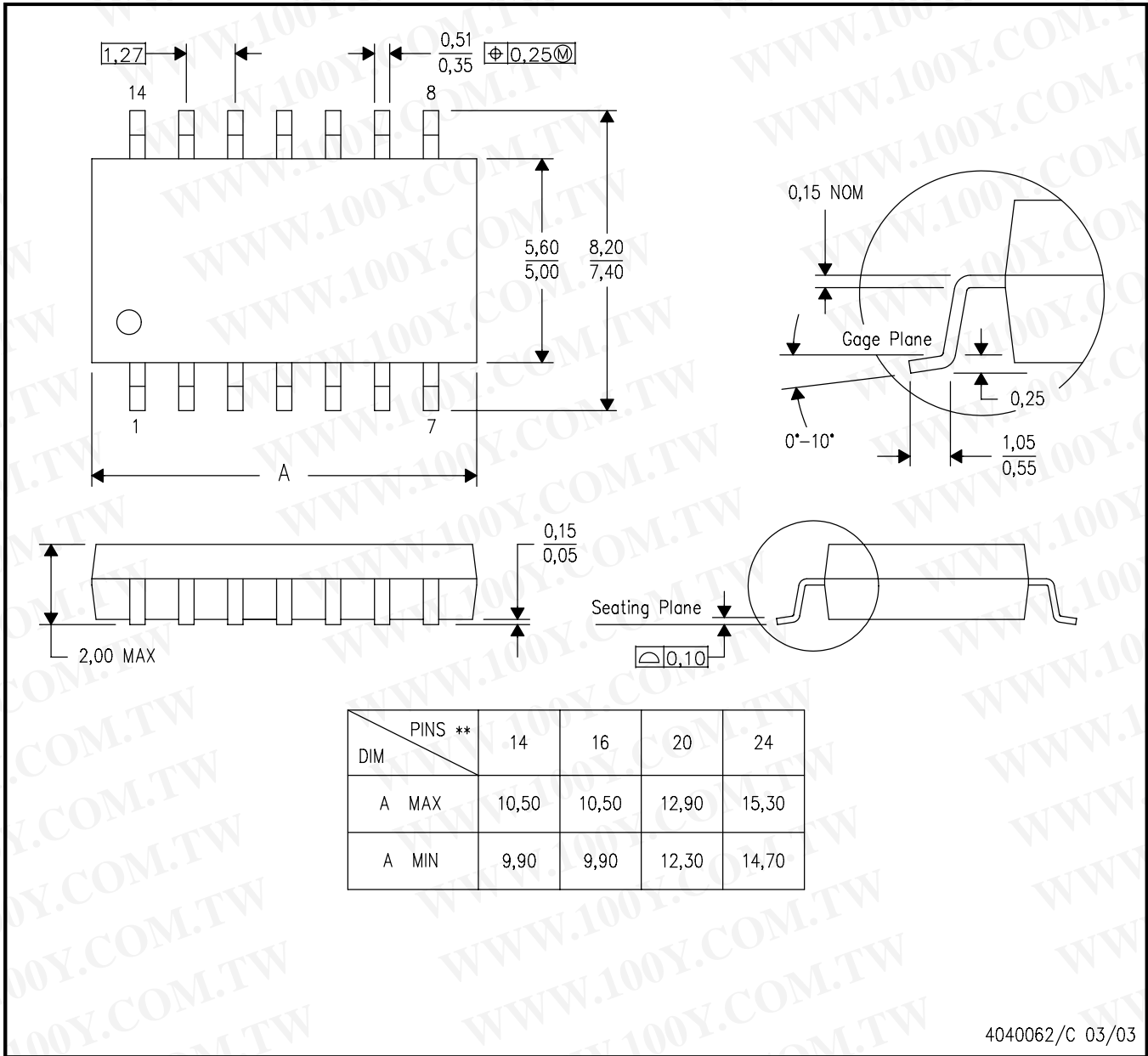
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# MECHANICAL DATA

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

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



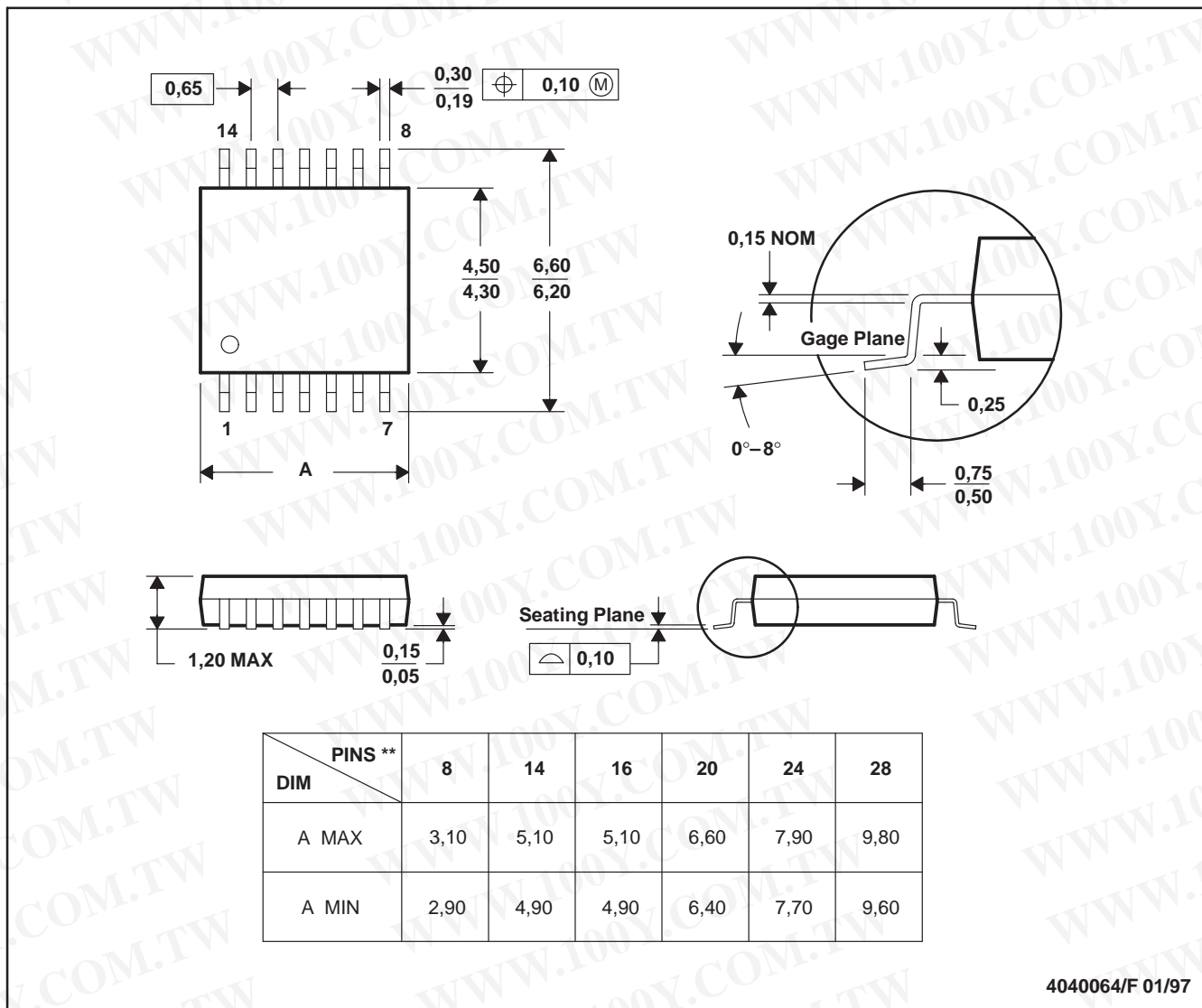
- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- 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.  
 D. Falls within JEDEC MO-153

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