

# CMOS 21-Stage Counter

High-Voltage Types (20-Volt Rating)

■ CD4045B is a timing circuit consisting of 21 counter stages, two output-shaping flip-flops, two inverter output drivers, and input inverters for use in a crystal oscillator. The CD4045B configuration provides 21 flip-flop counting stages, and two flip-flops for shaping the output waveform for a 3.125% duty cycle. Push-pull operation is provided by the inverter output drivers.

The first inverter is intended for use as a crystal oscillator/amplifier. However, it may be used as a normal logic inverter if desired. A crystal oscillator circuit can be made less sensitive to voltage-supply variations by the use of source resistors. In this device, the sources of the p and n transistors have been brought out to package terminals. If external resistors are not required, the sources must be shorted to their respective substrates ( $S_p$  to  $V_{DD}$ ,  $S_n$  to  $V_{SS}$ ). See Fig. 1. The first inverter in conjunction with an outboard inverter, such as 1/6 CD4069, and  $R_X$ ,  $C_X$ , and  $R_S$  can also be used to construct an RC oscillator. The following data is supplied as a guide in the selection of values for  $R_X$ ,  $R_S$ , and  $C_X$  used in Fig. 11:

1.  $R_X$  max = 10 M $\Omega$  with  $R_S$  = 10 M $\Omega$  and  $C_X$  = 50 pF
2.  $C_X$  max = 25  $\mu$ F with  $R_S$  = 560 k $\Omega$  and  $R_X$  = 50 k $\Omega$

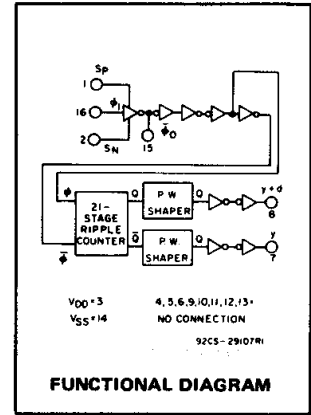
The CD4045B types are supplied in 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline package (NSR suffix), and 16-lead thin shrink small-outline packages (PW and PWR suffixes).

### Applications:

- Digital equipment in which ultra-low dissipation and/or operation using a battery source is required.
- Accurate timing from a crystal oscillator for timing applications such as wall clocks, table clocks, automobile clocks, and digital timing references in any circuit requiring accurately timed outputs at various intervals in the counting sequence.
- Driving miniature synchronous motors, stepping motors, or external bipolar transistors in push-pull fashion.

### Features:

- Very low operating dissipation . . . . . <1 mW (typ.) @  $V_{DD}$  = 5 V,  $f\phi$  = 1 MHz
- Output drivers with sink or source capability . . . . . 7 mA (typ.) @  $V_{DD}$  = 5 V
- Medium speed (typ.) . . . . .  $f\phi$  = 25 MHz @  $V_{DD}$  = 10 V
- 100% tested for quiescent current at 20 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"



### MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, ( $V_{DD}$ )	-0.5V to +20V
Voltages referenced to $V_{SS}$ Terminal	
INPUT VOLTAGE RANGE, ALL INPUTS	-0.5V to $V_{DD}$ + 0.5V
DC INPUT CURRENT, ANY ONE INPUT	$\pm$ 10mA
POWER DISSIPATION PER PACKAGE ( $P_D$ ):	
For $T_A$ = -55°C to +100°C	500mW
For $T_A$ = +100°C to +125°C	Derate Linearly at 12mW/°C to 200mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR	
FOR $T_A$ = FULL PACKAGE-TEMPERATURE RANGE (All Package Types)	100mW
OPERATING-TEMPERATURE RANGE ( $T_A$ )	-55°C to +125°C
STORAGE TEMPERATURE RANGE ( $T_{stg}$ )	-85°C to +150°C
LEAD TEMPERATURE (DURING SOLDERING):	
At distance 1/16 $\pm$ 1/32 inch (1.59 $\pm$ 0.79mm) from case for 10s max	+265°C

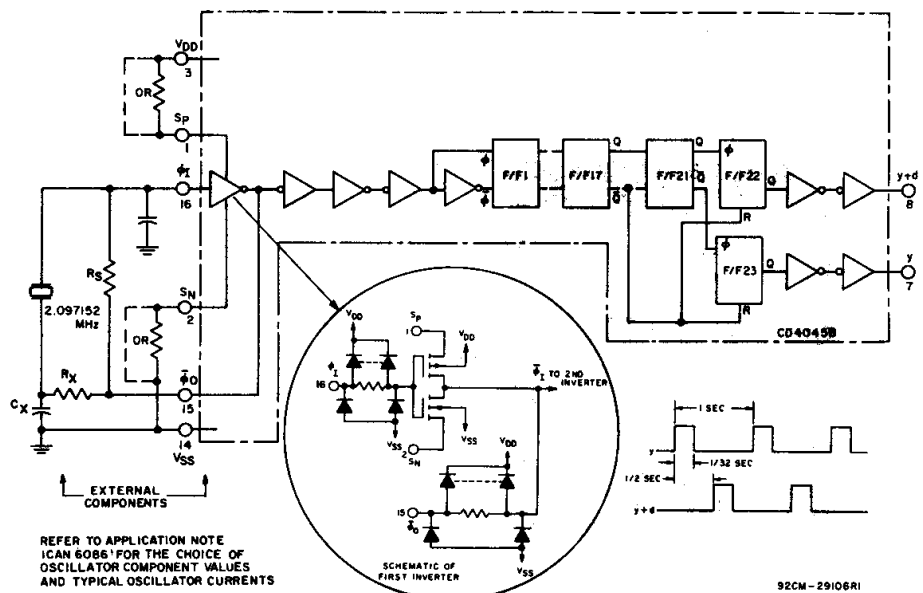


Fig. 1 - CD4045B and outboard components in a typical 21-stage counter application.

## CD4045B Types

### STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)	-55	-40	+85	+125	+25			
								Min.	Typ.	Max.	
Quiescent Device Current, I <sub>DD</sub> Max.	—	0,5	5	5	5	150	150	—	0,04	5	μA
	—	0,10	10	10	10	300	300	—	0,04	10	
	—	0,15	15	20	20	600	600	—	0,04	20	
	—	0,20	20	100	100	3000	3000	—	0,08	100	
Output Low (Sink) Current I <sub>OL</sub> Min.	0,4	0,5	5	4,5	4,3	2,9	2,5	3,6	7	—	mA
	0,5	0,10	10	11,2	10,5	7,7	6,3	9,1	18	—	
	1,5	0,15	15	29,4	28	19,6	16,8	23,8	47	—	
Output High (Source) Current, I <sub>OH</sub> Min.	4,6	0,5	5	-4,5	-4,3	-2,9	-2,5	-3,6	-7	—	mA
	9,5	0,10	10	-11,2	-10,5	-7,7	-6,3	-9,1	-18	—	
	13,5	0,15	15	-29,4	-28	-19,6	-16,8	-23,8	-47	—	
Pin 15 Output Low and High Current, I <sub>OL</sub> , I <sub>OH</sub>	0,4,4,6	0,5	5	—				±0,1	±0,18	—	mA
	0,5,9,5	0,10	10	—				±0,2	±0,3	—	
	1,5,13,5	0,15	15	—				±0,5	±1	—	
Output Voltage: Low-Level, V <sub>OL</sub> Max.	—	0,5	5	0,05				—	—	0,05	V
	—	0,10	10	0,05				—	—	0,05	
	—	0,15	15	0,05				—	—	0,05	
Output Voltage: High-Level, V <sub>OH</sub> 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 V <sub>IL</sub> 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, V <sub>IH</sub> 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 I <sub>IN</sub> Max.	—	0,18	18	±0,1	±0,1	±1	±1	—	±10 <sup>-5</sup>	±0,1	μA

### RECOMMENDED OPERATING CONDITIONS

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

CHARACTERISTIC	V <sub>DD</sub> (V)	LIMITS		UNITS
		Min.	Max.	
Supply-Voltage Range (For T <sub>A</sub> = Full Package-Temperature Range)	—	3	18	V
Minimum Input-Pulse Width, t <sub>w</sub>	5	—	100	ns
	10	—	50	
	15	—	40	
Maximum Input-Pulse Frequency, f <sub>φ</sub> (External Pulse Source)	5	5	—	MHz
	10	12	—	
	15	15	—	

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# CD4045B Types

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

CHARACTERISTIC	TEST CONDITIONS	$V_{DD}$ V	LIMITS			UNITS
			Min.	Typ.	Max.	
Propagation Delay Time: $\phi_1$ to y or y+d out $t_{PHL}, t_{PLH}$		5	—	2.2	5.5	$\mu\text{s}$
		10	—	0.9	2.7	
		15	—	0.65	2	
Transition Time: $t_{THL}, t_{TLH}$		5	—	25	50	ns
		10	—	13	25	
		15	—	10	20	
Minimum Input-Pulse Width $t_W$		5	—	50	100	ns
		10	—	25	50	
		15	—	20	40	
Input-Pulse Rise or Fall Time: $t_r\phi, t_f\phi$		5	—	—	500	$\mu\text{s}$
		10	—	—	500	
		15	—	—	500	
Maximum Input-Pulse Frequency: (External Pulse Source) $f_\phi$		5	5	10	—	MHz
		10	12	25	—	
		15	15	30	—	
Input Capacitance, $C_{IN}$	Any Input		—	5	7.5	pF
Variation of Output Frequency (Unit-to-Unit)	$f = 5\text{ MHz}$	5	—	0.05	—	%
		10	—	0.03	—	
		15	—	0.1	—	
<b>RC Oscillator Operation</b>						
Maximum Oscillator Frequency (See Fig. 11) $f_{osc}$	$R_X = 50\text{ k}\Omega$ , $R_S = 560\text{ k}\Omega$ , $C_X = 50\text{ pF}$	5	45	60	75	kHz
		10	45	60	75	
		15	45	60	75	

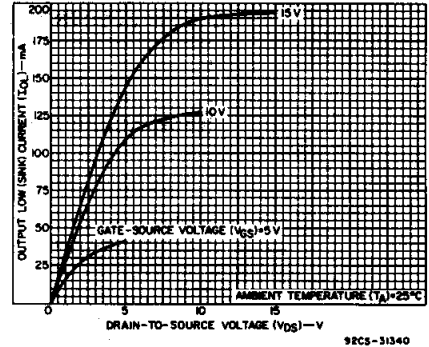


Fig. 2 — Typical output low (sink) current characteristics.

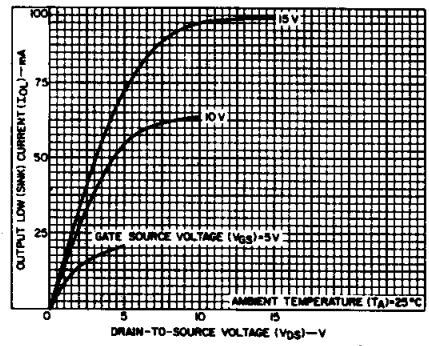


Fig. 3 — Minimum output low (sink) current characteristics.

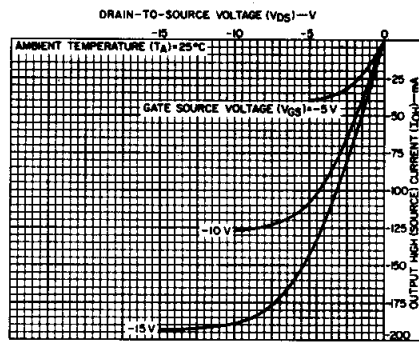


Fig. 4 — Typical output high (source) current characteristics.

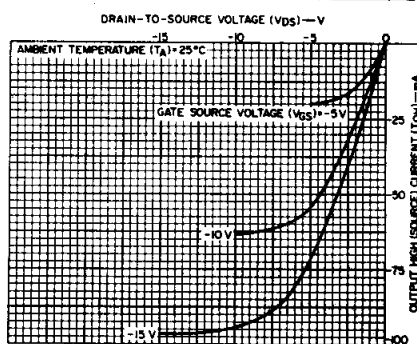


Fig. 5 — Minimum output high (source) current characteristics.

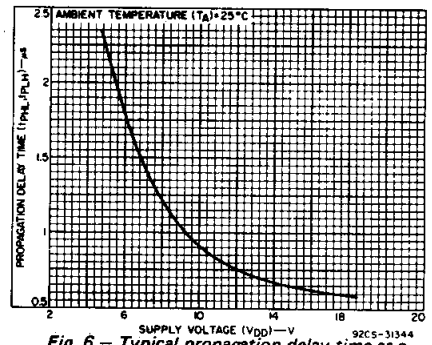


Fig. 6 — Typical propagation delay time as a function of supply voltage ( $\phi_1$  to y or y + d out vs.  $V_{DD}$ ).

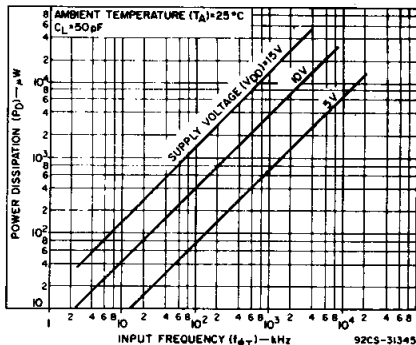


Fig. 7 — Typical power dissipation as a function of input frequency (21 counting stages).

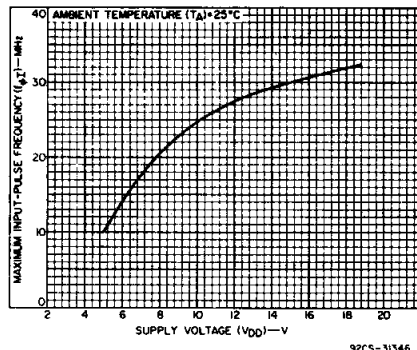


Fig. 8 — Typical maximum input-pulse frequency as a function of supply voltage.

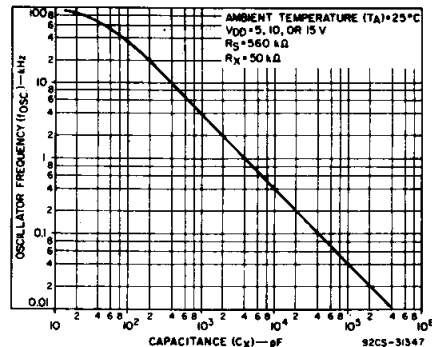


Fig. 9 — Typical RC oscillator frequency as a function of capacitance ( $C_X$ ), See Fig. 11.

# CD4045B Types

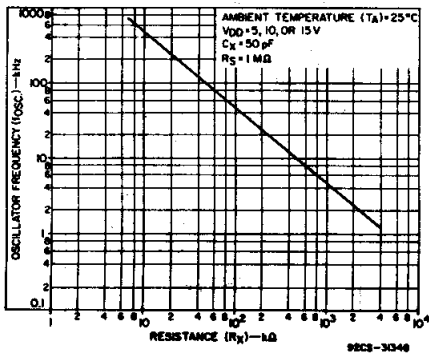


Fig. 10 - Typical RC oscillator frequency as a function of resistance ( $R_X$ ). See Fig. 11.

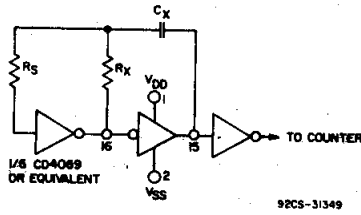


Fig. 11 - Typical RC circuit.

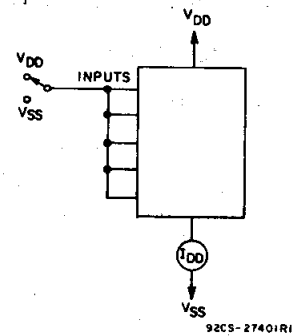


Fig. 12 - Quiescent-device-current test circuit.

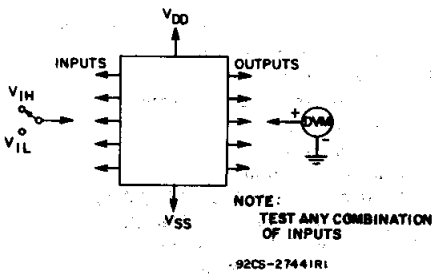


Fig. 13 - Noise-immunity test circuit.

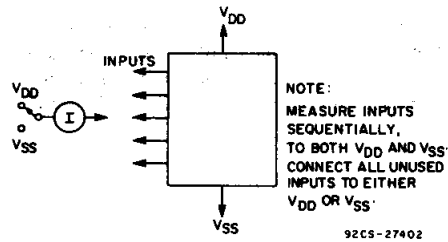


Fig. 14 - Input-leakage-current test circuit.

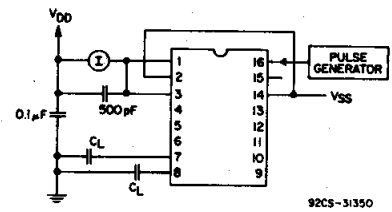
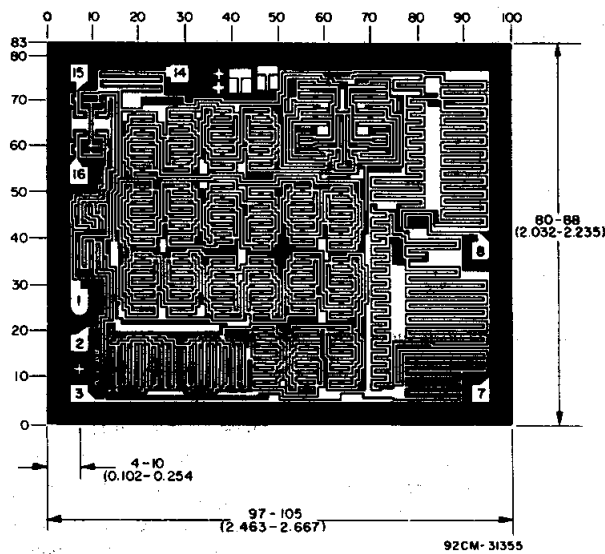


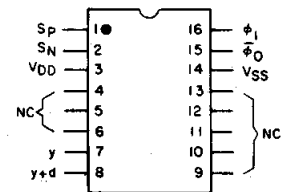
Fig. 15 - Dynamic power dissipation test circuit.



Chip dimensions and pad layout for CD4045B

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

## TERMINAL DIAGRAM Top View



NC = NO CONNECTION

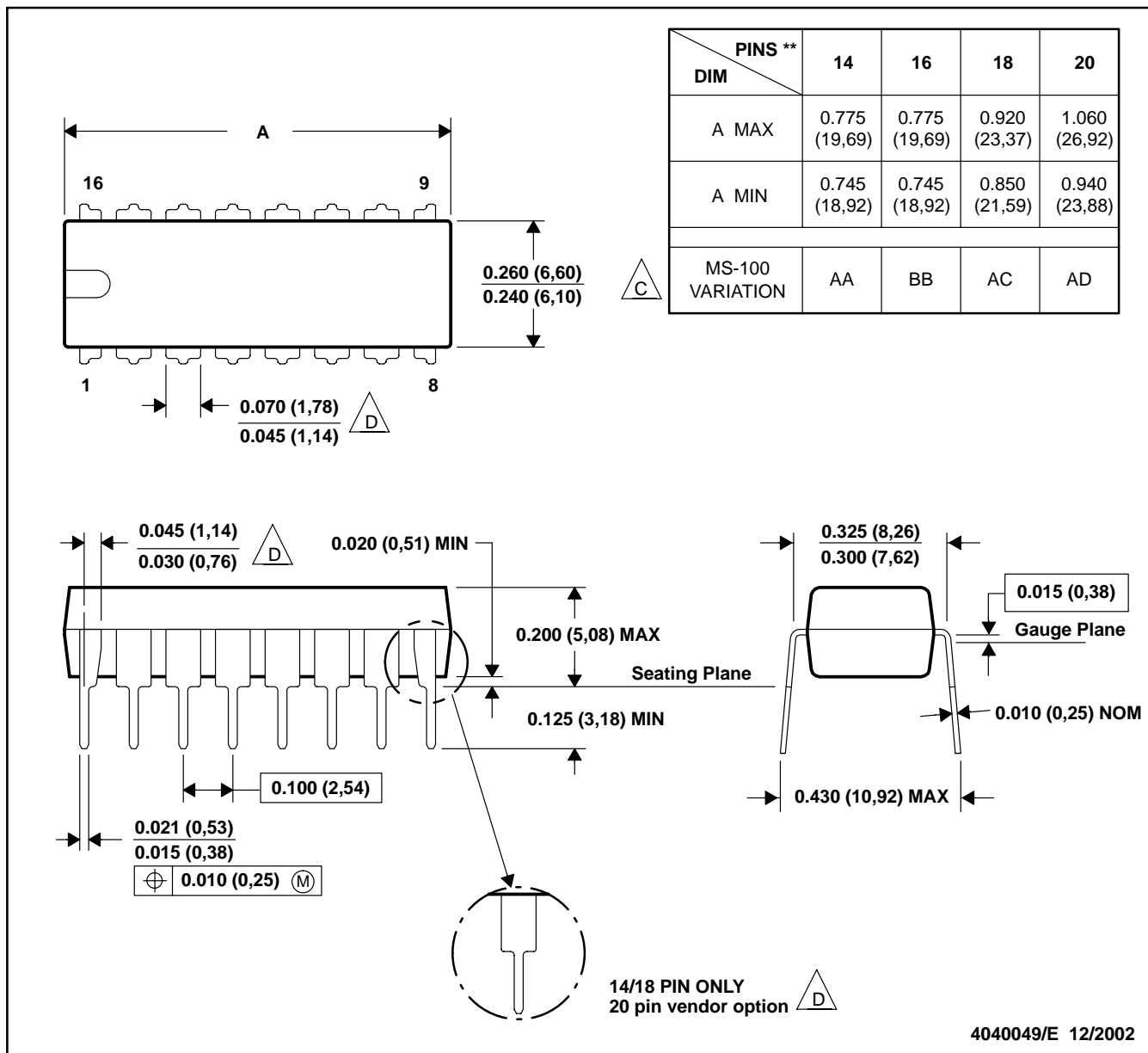
**NOTE** Observe power-supply terminal connections,  $V_{DD}$  is terminal No. 3 and  $V_{SS}$  is terminal No. 14 (not 16 and 8 respectively, as in other CD4000B Series 16-lead devices).

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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.

## 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.

PW (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.  
 D. Falls within JEDEC MO-153

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