TEXAS INSTRUMENTS
Data sheet acquired from Harris Semiconductor
SCHS042C – Revised July 2003

# CD4045B Types

## 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 MΩ with $R_S$ = 10 MΩ and $C_X$ = 50 pF
2. $C_X$ max = 25 μF with $R_S$ = 560 kΩ and $R_X$ = 50 kΩ

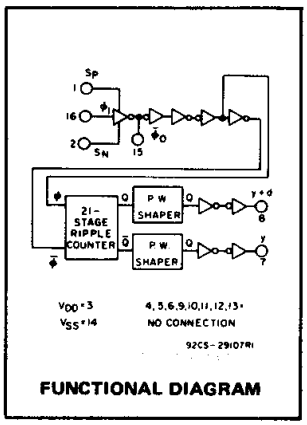
The CD4045B types are supplied in 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline package (NSR suffix), and 16-lead thin shrink small-outline packages (PW and PWR suffixes).

### *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, fϕ = 1 MHz**
- **Output drivers with sink or source capability . . . . . 7 mA (typ.) @ $V_{DD}$ = 5 V**
- **Medium speed (typ.) . . . fϕ = 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 Descripiton of 'B' Series CMOS Devices"**




**FUNCTIONAL DIAGRAM**

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

DC SUPPLY-VOLTAGE RANGE, ($V_{DD}$)
(Voltages referenced to $V_{SS}$ Terminal) ..... -0.5V to +20V
INPUT VOLTAGE RANGE, ALL INPUTS ..... -0.5V to $V_{DD}$ +0.5V
DC INPUT CURRENT, ANY ONE INPUT ..... ±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 Linearity 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 ($T_{stg}$) ..... -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 ..... +265°C

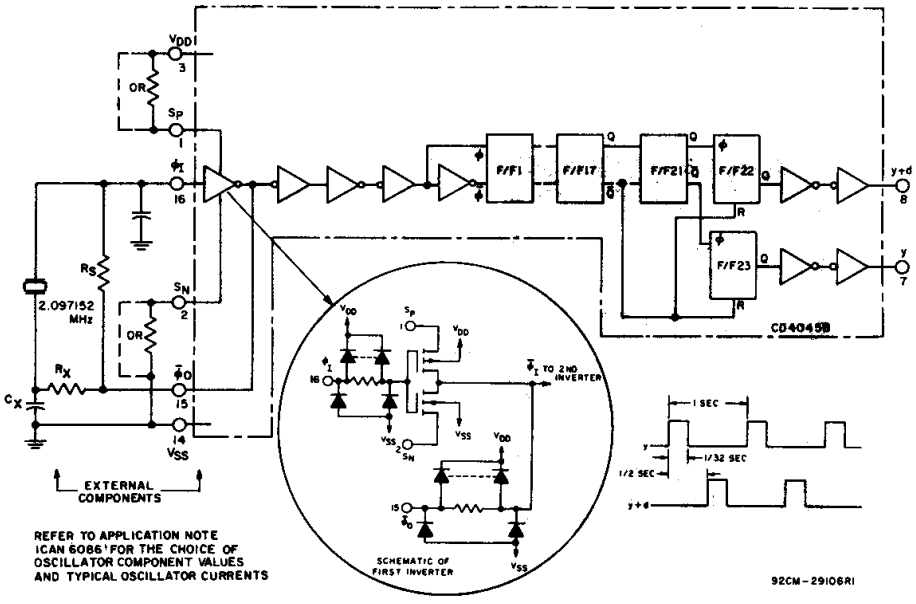



*Fig. 1 – CD4045B and outboard components in a typical 21-stage counter application.*

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## STATIC ELECTRICAL CHARACTERISTICS

| CHARACTERISTIC | CONDITIONS | | | LIMITS AT INDICATED TEMPERATURES (°C) | | | | | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_O$ (V) | $V_{IN}$ (V) | $V_{DD}$ (V) | −55 | −40 | +85 | +125 | +25 Min. | +25 Typ. | +25 Max. | |
| Quiescent Device Current, $I_{DD}$ 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 $I_{OL}$ 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, $I_{OH}$ Min. | 4.6 | 0,5 | 5 | −4.5 | −4.3 | −2.9 | −2.5 | −3.6 | −7 | – | |
| | 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, $I_{OL}$, $I_{OH}$ | 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, $V_{OL}$ 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, $V_{OH}$ Min. | – | 0,5 | 5 | 4.95 | | | | 4.95 | 5 | – | |
| | – | 0,10 | 10 | 9.95 | | | | 9.95 | 10 | – | |
| | – | 0,15 | 15 | 14.95 | | | | 14.95 | 15 | – | |
| Input Low Voltage $V_{IL}$ 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, $V_{IH}$ Min. | 0.5,4.5 | – | 5 | 3.5 | | | | 3.5 | – | – | |
| | 1,9 | – | 10 | 7 | | | | 7 | – | – | |
| | 1.5,13.5 | – | 15 | 11 | | | | 11 | – | – | |
| Input Current $I_{IN}$ Max. | – | 0,18 | 18 | ±0.1 | ±0.1 | ±1 | ±1 | – | $\pm 10^{-5}$ | ±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 | $V_{DD}$ (V) | LIMITS Min. | LIMITS Max. | UNITS |
|---|---|---|---|---|
| Supply-Voltage Range (For $T_A$ = Full Package-Temperature Range) | – | 3 | 18 | V |
| Minimum Input-Pulse Width, $t_W$ | 5 | – | 100 | ns |
| | 10 | – | 50 | |
| | 15 | – | 40 | |
| Maximum Input–Pulse Frequency, fϕ (External Pulse Source) | 5 | 5 | – | MHz |
| | 10 | 12 | – | |
| | 15 | 15 | – | |

**DYNAMIC ELECTRICAL CHARACTERISTICS at $T_A$ = 25°C; Input $t_r$, $t_f$ = 20 ns, $C_L$ = 50 pF, $R_L$ = 200 kΩ**

| CHARACTERISTIC | TEST CONDITIONS | $V_{DD}$ V | LIMITS Min. | Typ. | Max. | UNITS |
|---|---|---|---|---|---|---|
| Propagation Delay Time: $\phi_I$ to y or y+d out $t_{PHL}$, $t_{PLH}$ | | 5 | – | 2.2 | 5.5 | μs |
| | | 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 | |
| | | 10 | – | 25 | 50 | |
| | | 15 | – | 20 | 40 | |
| Input-Pulse Rise or Fall Time: $t_r\phi$, $t_f\phi$ | | 5 | – | – | 500 | μs |
| | | 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 MHz | 5 | – | 0.05 | – | % |
| | | 10 | – | 0.03 | – | |
| | | 15 | – | 0.1 | – | |
| **RC Oscillator Operation** | | | | | | |
| Maximum Oscillator Frequency (See Fig. 11) $f_{osc}$ | $R_X$ = 50 kΩ, $R_S$ = 560 kΩ, $C_X$ = 50 pF | 5 | 45 | 60 | 75 | kHz |
| | | 10 | 45 | 60 | 75 | |
| | | 15 | 45 | 60 | 75 | |

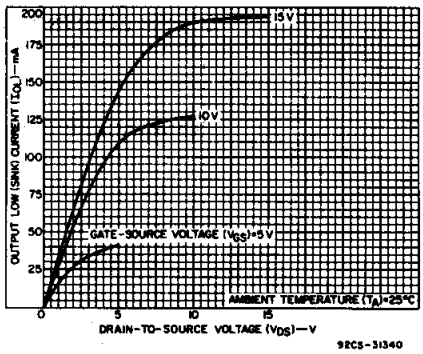



*Fig. 2 – Typical output low (sink) current characteristics.*

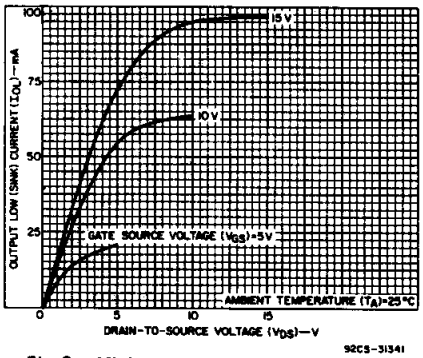



*Fig. 3 – Minimum output low (sink) current characteristics.*

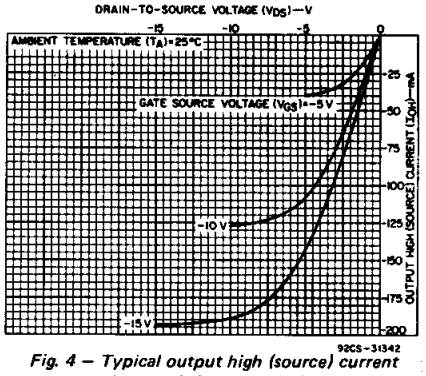



*Fig. 4 – Typical output high (source) current characteristics.*

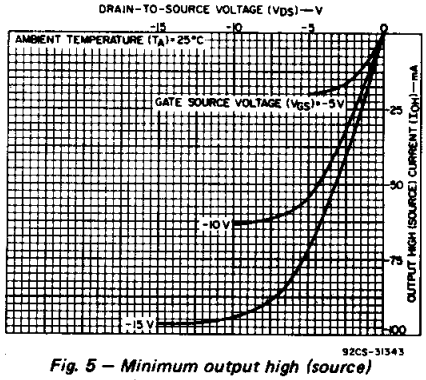



*Fig. 5 – Minimum output high (source) characteristics.*

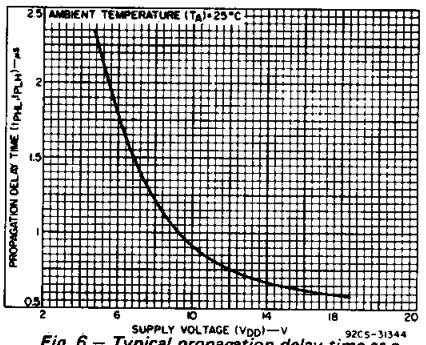



*Fig. 6 – Typical propagation delay time as a function of supply voltage ($\phi_I$ to y or y + d out vs. $V_{DD}$).*

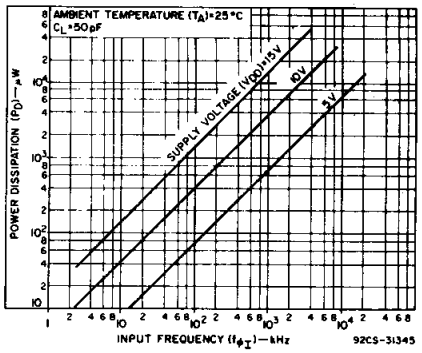



*Fig. 7 – Typical power dissipation as a function of input frequency (21 counting stages).*

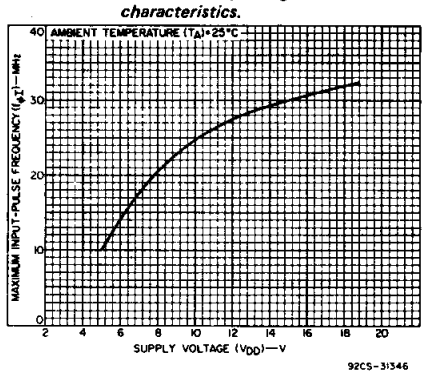



*Fig. 8 – Typical maximum input-pulse frequency as a function of supply voltage.*

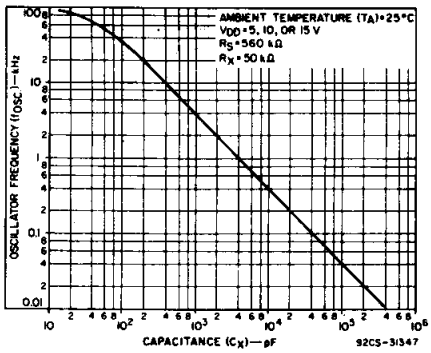



*Fig. 9 – Typical RC oscillator frequency as a function of capacitance ($C_X$), See Fig. 11.*

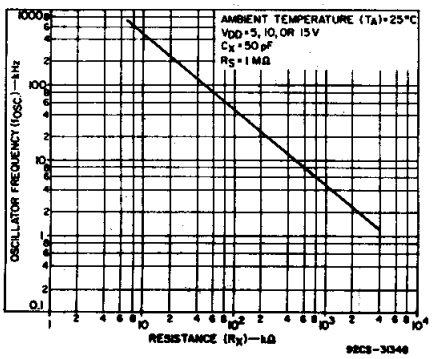



*Fig. 10 – Typical RC oscillator frequency as a function of resistance ($R_X$), See Fig. 11.*

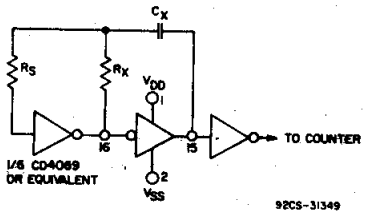



*Fig. 11 – Typical RC circuit.*

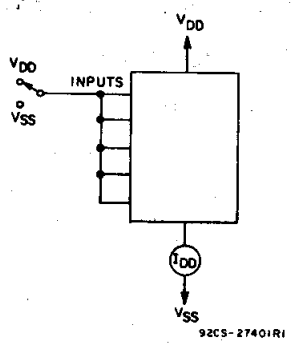



*Fig. 12 – Quiescent-device-current test circuit.*

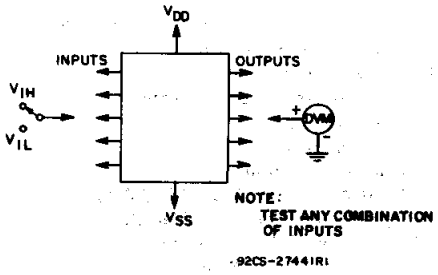



*Fig. 13 – Noise-immunity test circuit.*

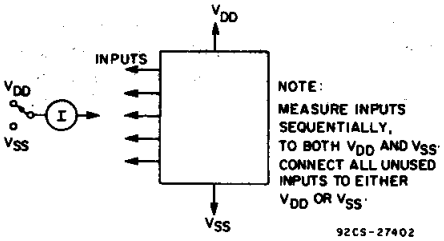



*Fig. 14 – Input-leakage-current test circuit.*

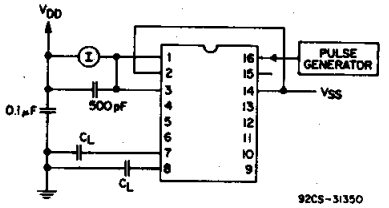
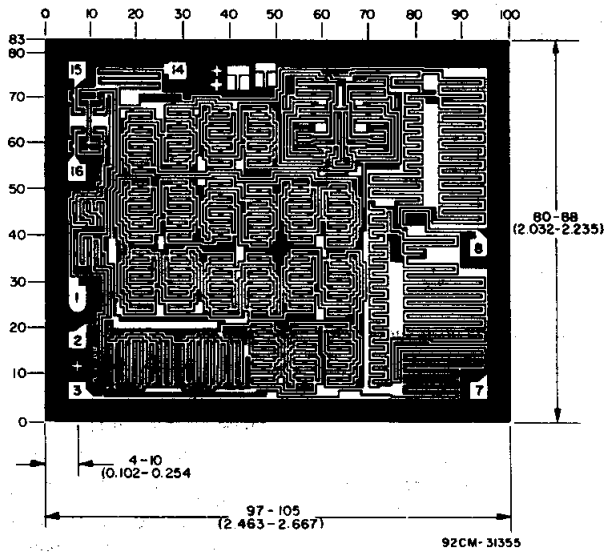


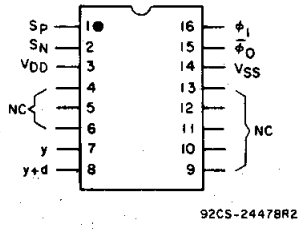

*Fig. 15 – Dynamic power dissipation test circuit.*




*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).

## PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| CD4045BE | Active | Production | PDIP (N) \| 16 | 25 \| TUBE | Yes | NIPDAU | N/A for Pkg Type | -55 to 125 | CD4045BE |
| CD4045BE.A | Active | Production | PDIP (N) \| 16 | 25 \| TUBE | Yes | NIPDAU | N/A for Pkg Type | -55 to 125 | CD4045BE |

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

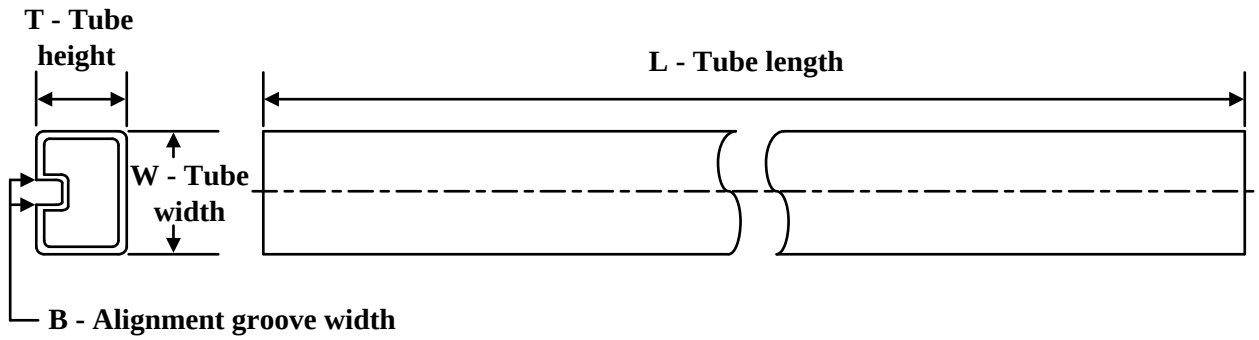
(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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## TUBE



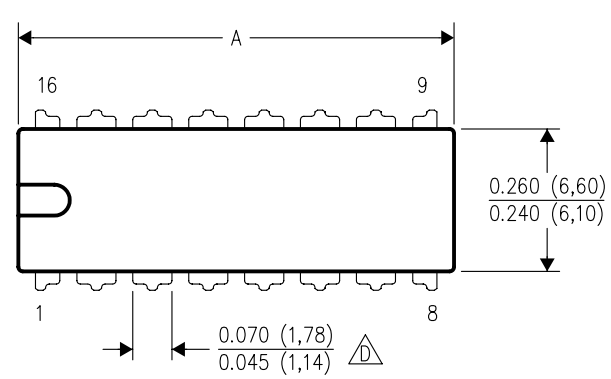

*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (µm) | B (mm) |
|---|---|---|---|---|---|---|---|---|
| CD4045BE | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD4045BE | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD4045BE.A | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD4045BE.A | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 4.32 |

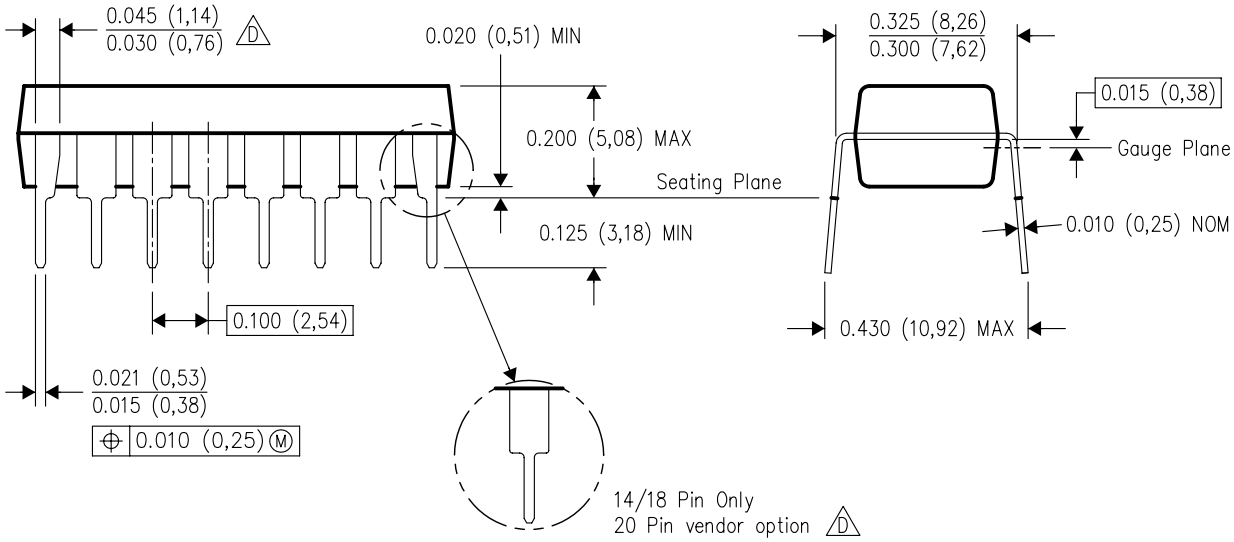
## N (R–PDIP–T**)

## PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN




| DIM \ PINS ** | 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–001 VARIATION (C) | AA | BB | AC | AD |




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 length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

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