# CD4020B, CD4024B, CD4040B Types

## CMOS Ripple-Carry Binary Counter/Dividers

High-Voltage Types (20-Volt Rating)

CD4020B – 14 Stage
CD4024B – 7 Stage
CD4040B – 12 Stage

■ CD4020B, CD4024B, and CD4040B are ripple-carry binary counters. All counter stages are master-slave flip-flops. The state of a counter advances one count on the negative transition of each input pulse; a high level on the RESET line resets the counter to its all zeros state. Schmitt trigger action on the input-pulse line permits unlimited rise and fall times. All inputs and outputs are buffered.

The CD4020B and CD4040B 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 (NSR suffix), and 16-lead thin shrink small-outline packages (PW and PWR suffixes).

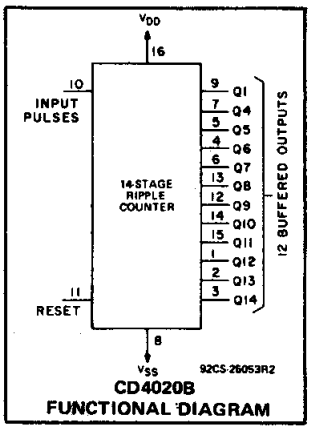
The CD4024B types are supplied in 14-lead hermetic dual-in-line ceramic packages (F3A suffix), 14-lead dual-in-line plastic packages (E suffix), 14-lead small-outline packages (M, M96, and NSR suffixes), and 14-lead thin shrink small-outline packages (PW and PWR suffixes).

*Features:*

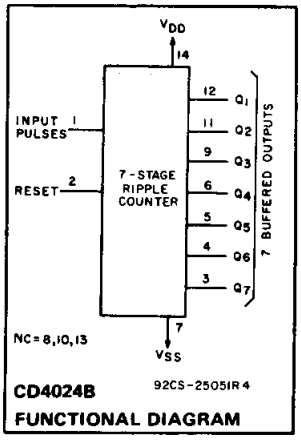
- Medium-speed operation
- Fully static operation
- Buffered inputs and outputs
- 100% tested for quiescent current at 20 V
- Standardized, symmetrical output characteristics
- Fully static operation
- Common reset
- 5-V, 10-V, and 15-V parametric ratings
- Maximum input current of 1 μA at 18 V over full package-temperature range; 100 nA at 18 V and 25°C
- Noise margin (over full package-temperature range): 1 V at $V_{DD}$ = 5 V; 2 V at $V_{DD}$ = 10 V; 2.5 V at $V_{DD}$ = 15 V
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

*Applications:*

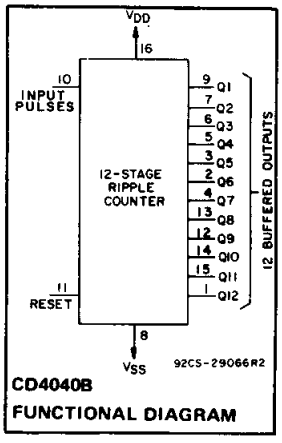
- Control counters
- Timers
- Frequency dividers
- Time-delay circuits



CD4020B
FUNCTIONAL DIAGRAM



CD4024B
FUNCTIONAL DIAGRAM



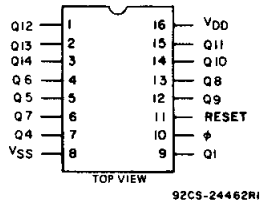
CD4040B
FUNCTIONAL DIAGRAM

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

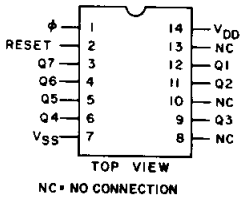
DC SUPPLY-VOLTAGE RANGE, ($V_{DD}$)
(Voltages referenced to $V_{SS}$ Terminal) ..... -0.5V to +20V
INPUT VOLTAGE RANGE, ALL INPUTS ..... -0.5V to $V_{DD}$ +0.5V
DC INPUT CURRENT, ANY ONE INPUT ..... ±10mA
POWER DISSIPATION PER PACKAGE ($P_D$):
For $T_A$ = -55°C to +100°C ..... 500mW
For $T_A$ = +100°C 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

### TERMINAL ASSIGNMENTS

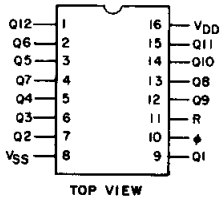
CD4020B




CD4024B




CD4040B



**RECOMMENDED OPERATING CONDITIONS at $T_A$ = 25°C, Unless Otherwise Specified**

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

| CHARACTERISTIC | | $V_{DD}$ | Min. | Max. | UNITS |
|---|---|---|---|---|---|
| Supply Voltage Range (at $T_A$ = Full Package-Temperature Range) | | | 3 | 18 | V |
| Input-Pulse Frequency, | $f_\phi$ | 5<br>10<br>15 | –<br>–<br>– | 3.5<br>8<br>12 | MHz |
| Input-Pulse Width, | $t_W$ | 5<br>10<br>15 | 140<br>60<br>40 | –<br>–<br>– | ns |
| Input-Pulse Rise or Fall Time, | $t_{r\phi}$, $t_{f\phi}$ | 5<br>10<br>15 | Unlimited | | μs |
| Reset Pulse Width, | $t_W$ | 5<br>10<br>15 | 200<br>80<br>60 | – | ns |
| Reset Removal Time, | $t_{REM}$ | 5<br>10<br>15 | 350<br>150<br>100 | –<br>–<br>– | ns |

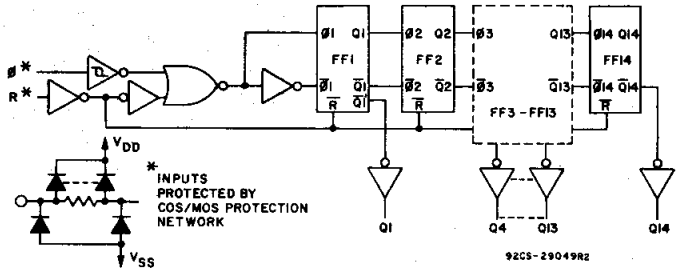



*Fig. 1 – Logic diagram for CD4020B.*

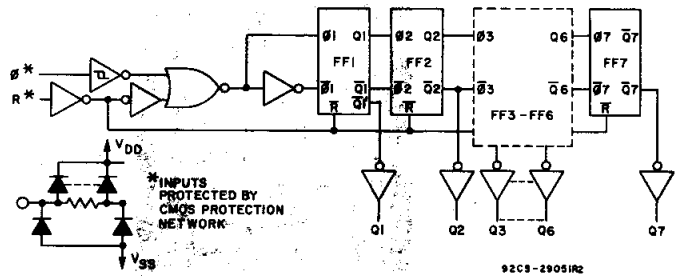



*Fig. 2 – Logic diagram for CD4024B.*

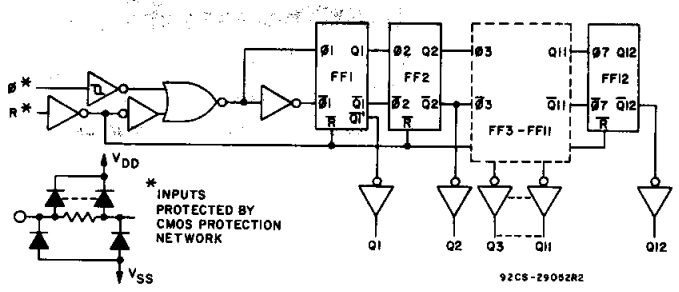



*Fig. 3 – Logic diagram for CD4040B.*

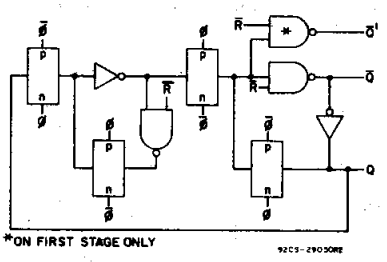



*Fig. 4 – Detail of typical flip-flop stage.*

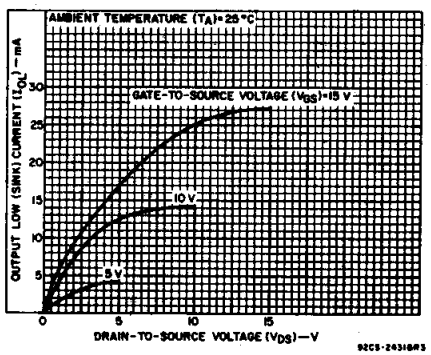



*Fig. 5 – Typical output low (sink) current characteristics.*

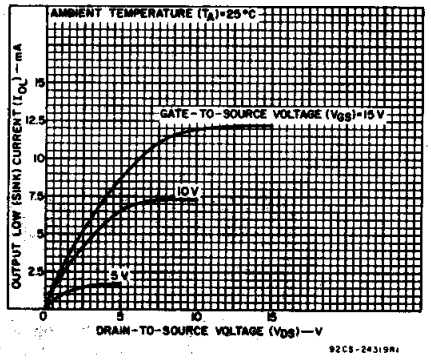



*Fig. 6 – Minimum output low (sink) current characteristics.*

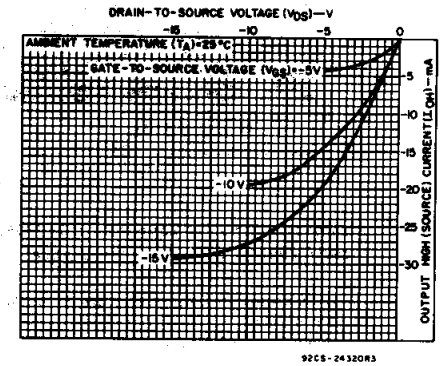



*Fig. 7 – Typical output high (source) current characteristics.*

**STATIC ELECTRICAL CHARACTERISTICS**

| CHARACTERISTIC | CONDITIONS | | | LIMITS AT INDICATED TEMPERATURES (°C) | | | | | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | +25 | | | |
| | $V_O$ (V) | $V_{IN}$ (V) | $V_{DD}$ (V) | −55 | −40 | +85 | +125 | Min. | Typ. | 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 | 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, $I_{OH}$ Min. | 4.6 | 0,5 | 5 | −0.64 | −0.61 | −0.42 | −0.36 | −0.51 | −1 | – | |
| | 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, $V_{OL}$ 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, $V_{OH}$ 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 |

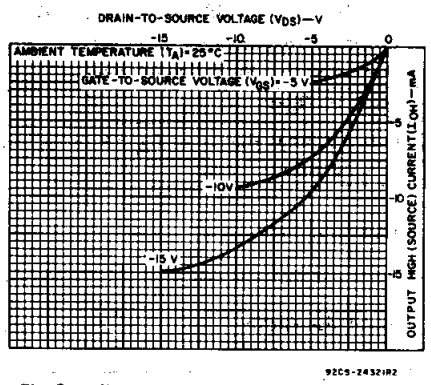



*Fig. 8 – Minimum output high (source) current characteristics.*

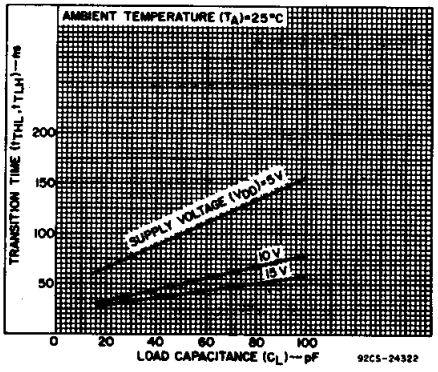
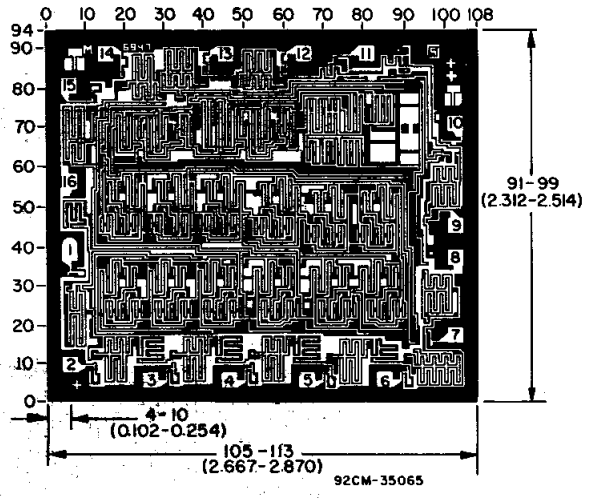
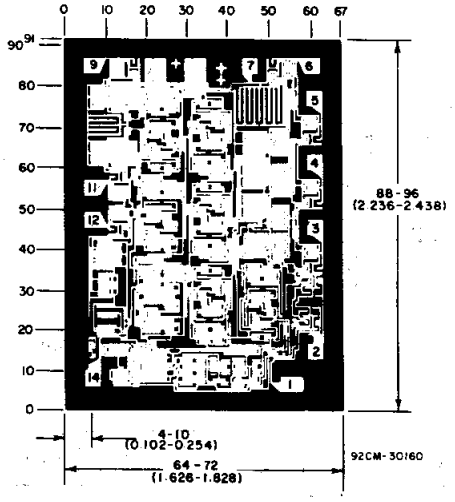



*Fig. 9 – Typical transition time as a function of load capacitance.*




*Dimensions and Pad Layout for CD4020BH. Dimensions and pad layout for CD4040BH are identical.*




*Dimensions and Pad Layout for CD4024BH.*

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

**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 |
|---|---|---|---|---|---|---|
| **Input-Pulse Operation** | | | | | | |
| Propagation Delay Time, $\phi$ to $Q_1$ Out; $t_{PHL}$, $t_{PLH}$ | | 5 | – | 180 | 360 | ns |
| | | 10 | – | 80 | 160 | |
| | | 15 | – | 65 | 130 | |
| $Q_n$ to $Q_n$ + 1; $t_{PHL}$, $t_{PLH}$ | | 5 | – | 100 | 330 | ns |
| | | 10 | – | 40 | 80 | |
| | | 15 | – | 30 | 60 | |
| Transition Time, $t_{THL}$, $t_{TLH}$ | | 5 | – | 100 | 200 | ns |
| | | 10 | – | 50 | 100 | |
| | | 15 | – | 40 | 80 | |
| Minimum Input-Pulse Width, $t_W$ | | 5 | – | 70 | 140 | ns |
| | | 10 | – | 30 | 60 | |
| | | 15 | – | 20 | 40 | |
| Input-Pulse Rise or Fall Time, $t_{r\phi}$, $t_{f\phi}$ | | 5 | Unlimited | | | μs |
| | | 10 | | | | |
| | | 15 | | | | |
| Maximum Input-Pulse Frequency, $f_\phi$ | | 5 | 3.5 | 7 | – | MHz |
| | | 10 | 8 | 16 | – | |
| | | 15 | 12 | 24 | – | |
| Input Capacitance, $C_I$ | Any Input | | – | 5 | 7.5 | pF |
| **Reset Operation** | | | | | | |
| Propagation Delay Time, $t_{PHL}$ | | 5 | – | 140 | 280 | ns |
| | | 10 | – | 60 | 120 | |
| | | 15 | – | 50 | 100 | |
| Minimum Reset Pulse Width, $t_W$ | | 5 | – | 100 | 200 | ns |
| | | 10 | – | 40 | 80 | |
| | | 15 | – | 30 | 60 | |
| Reset Removal Time, $t_{REM}$ | | 5 | – | 175 | 350 | ns |
| | | 10 | – | 75 | 150 | |
| | | 15 | – | 50 | 100 | |

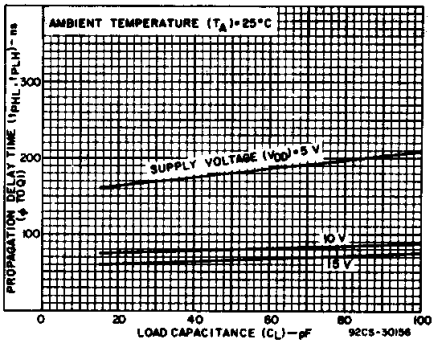



*Fig. 10 – Typical propagation delay time as a function of load capacitance ($\phi$ to $Q_1$).*

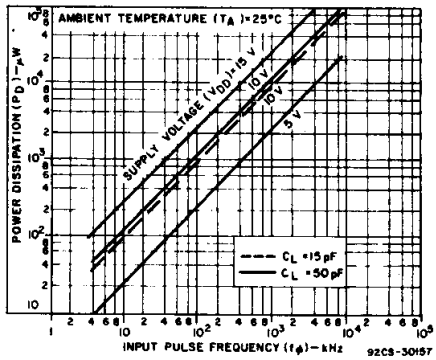



*Fig. 11 – Typical dynamic power dissipation as a function of input pulse frequency for CD4020B.*

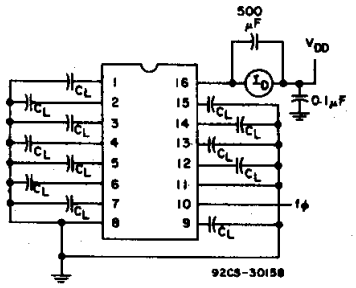



*Fig. 12 – Dynamic power dissipation test circuit for CD4020B.*

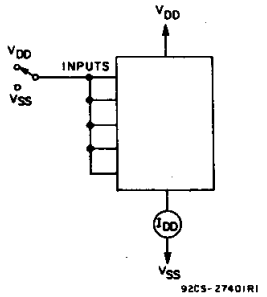



*Fig. 13 – Quiescent device current test circuit.*

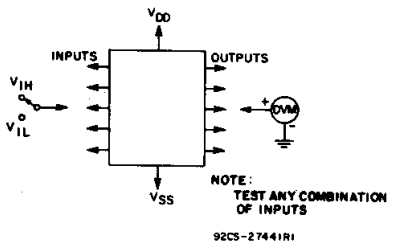



*Fig. 14 – Input voltage test circuits.*

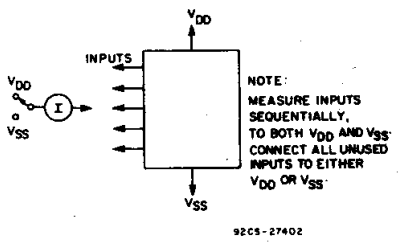
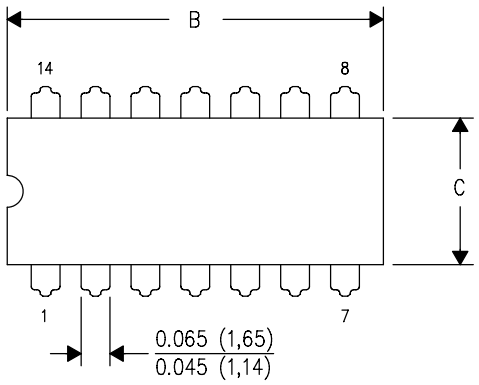



*Fig. 15 – Input current test circuit.*

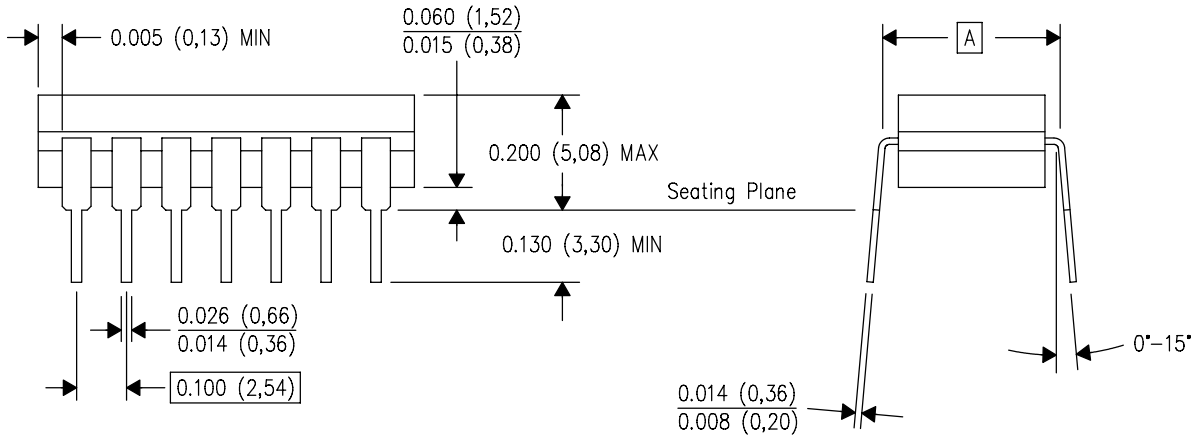
J (R–GDIP–T**)

14 LEADS SHOWN

# CERAMIC DUAL IN–LINE PACKAGE




| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC |
| B MAX | 0.785 (19,94) | .840 (21,34) | 0.960 (24,38) | 1.060 (26,92) |
| B MIN | — | — | — | — |
| C MAX | 0.300 (7,62) | 0.300 (7,62) | 0.310 (7,87) | 0.300 (7,62) |
| C MIN | 0.245 (6,22) | 0.245 (6,22) | 0.220 (5,59) | 0.245 (6,22) |



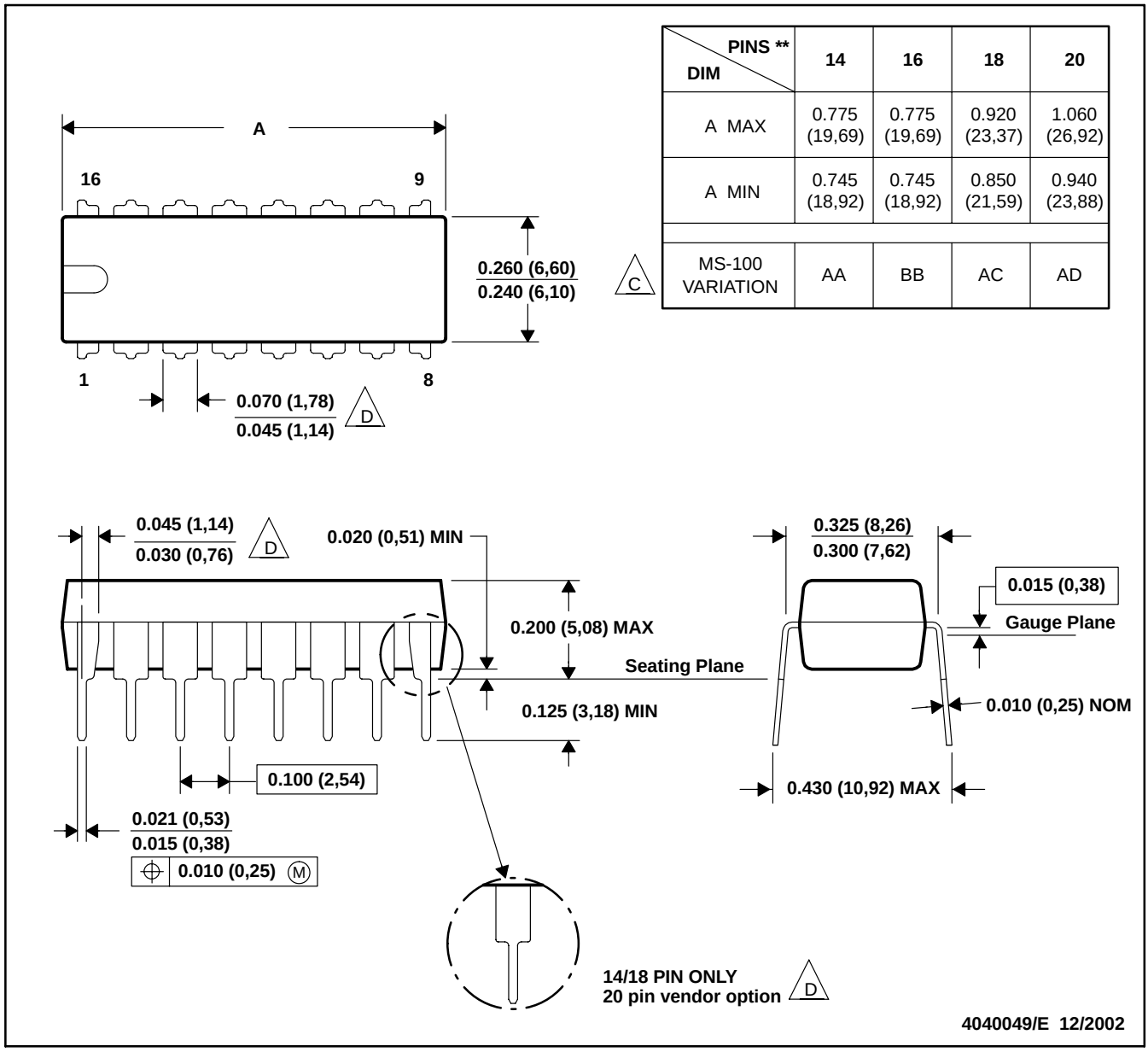

4040083/F 03/03

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 only on press ceramic glass frit seal only.
E. Falls within MIL STD 1835 GDIP1–T14, GDIP1–T16, GDIP1–T18 and GDIP1–T20.

## 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-100 VARIATION | AA | BB | AC | AD |

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).

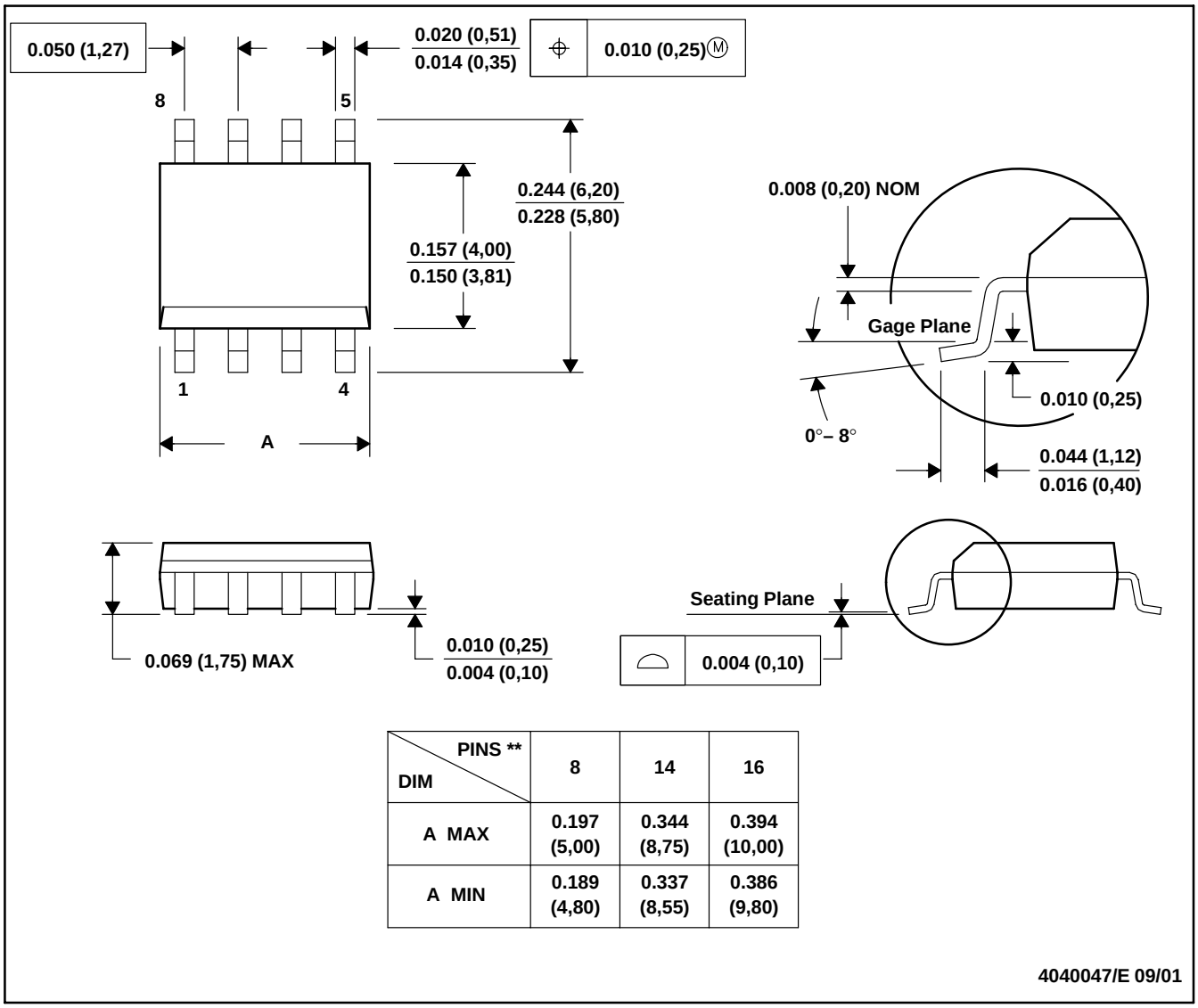
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

MSOI002B – JANUARY 1995 – REVISED SEPTEMBER 2001

## D (R-PDSO-G**)

## PLASTIC SMALL-OUTLINE PACKAGE

**8 PINS SHOWN**




| DIM \ PINS ** | 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) |

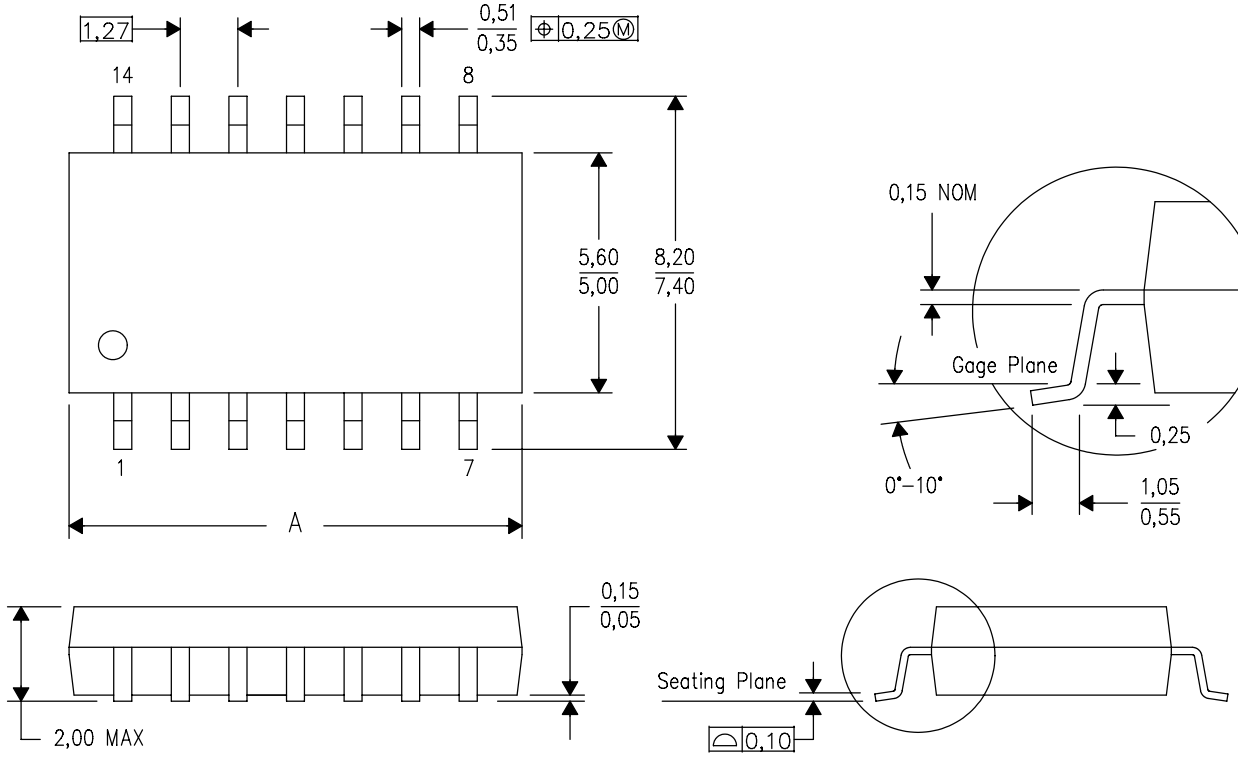
4040047/E 09/01

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

## MECHANICAL DATA

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

**14-PINS SHOWN**



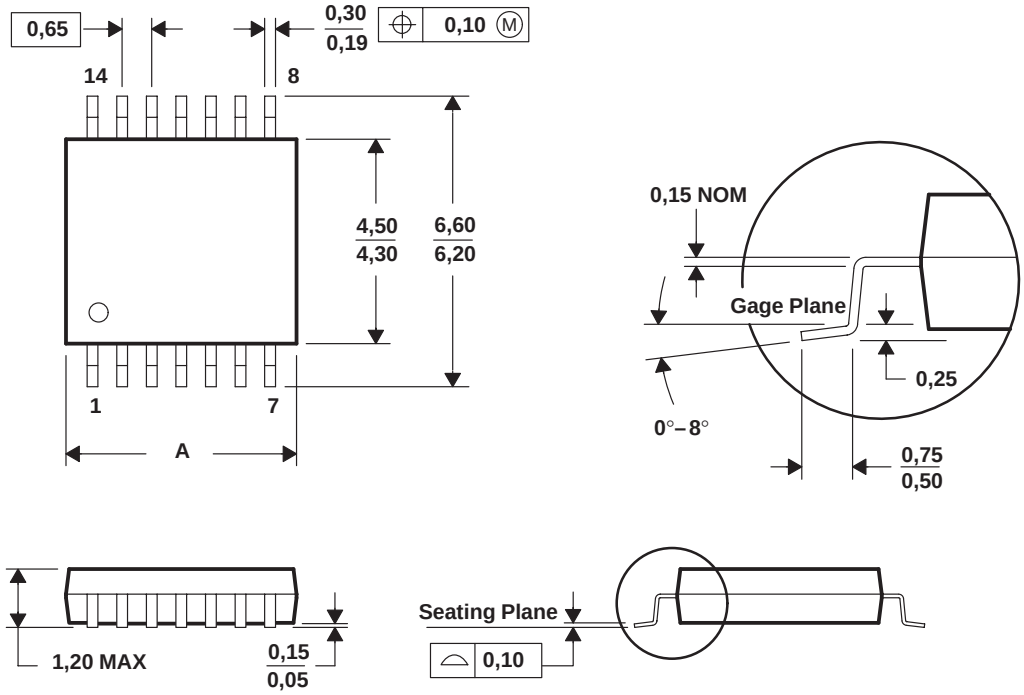

| DIM \ PINS ** | 14 | 16 | 20 | 24 |
|---|---|---|---|---|
| A MAX | 10,50 | 10,50 | 12,90 | 15,30 |
| A MIN | 9,90 | 9,90 | 12,30 | 14,70 |

4040062/C 03/03

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**




| DIM \ PINS ** | 8 | 14 | 16 | 20 | 24 | 28 |
|---|---|---|---|---|---|---|
| A MAX | 3,10 | 5,10 | 5,10 | 6,60 | 7,90 | 9,80 |
| A MIN | 2,90 | 4,90 | 4,90 | 6,40 | 7,70 | 9,60 |

**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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