

High-Speed CMOS Logic Dual 4-Stage Binary Counter

Features

- Fully Static Operation
- Buffered Inputs
- Common Reset
- Negative-Edge Clocking
- Fanout (Over Temperature Range)
 - Standard Outputs 10 LSTTL Loads
 - Bus Driver Outputs 15 LSTTL Loads
- Wide Operating Temperature Range . . . -55°C to 125°C
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- HC Types
 - 2V to 6V Operation
 - High Noise Immunity: $N_{IL} = 30\%$, $N_{IH} = 30\%$ of V_{CC} at $V_{CC} = 5V$
- HCT Types
 - 4.5V to 5.5V Operation
 - Direct LSTTL Input Logic Compatibility, $V_{IL} = 0.8V$ (Max), $V_{IH} = 2V$ (Min)
 - CMOS Input Compatibility, $I_I \leq 1\mu A$ at V_{OL} , V_{OH}

Description

The 'HC393 and 'HCT393 are 4-stage ripple-carry binary counters. All counter stages are master-slave flip-flops. The state of the stage advances one count on the negative transition of each clock pulse; a high voltage level on the MR line resets all counters to their zero state. All inputs and outputs are buffered.

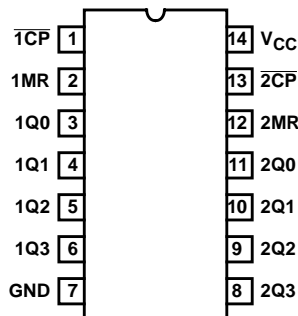
Ordering Information

| PART NUMBER | TEMP. RANGE (°C) | PACKAGE |
|---------------|------------------|--------------|
| CD54HC393F3A | -55 to 125 | 14 Ld CERDIP |
| CD54HCT393F3A | -55 to 125 | 14 Ld CERDIP |
| CD74HC393E | -55 to 125 | 14 Ld PDIP |
| CD74HC393M | -55 to 125 | 14 Ld SOIC |
| CD74HC393MT | -55 to 125 | 14 Ld SOIC |
| CD74HC393M96 | -55 to 125 | 14 Ld SOIC |
| CD74HCT393E | -55 to 125 | 14 Ld PDIP |
| CD74HCT393M | -55 to 125 | 14 Ld SOIC |
| CD74HCT393MT | -55 to 125 | 14 Ld SOIC |
| CD74HCT393M96 | -55 to 125 | 14 Ld SOIC |

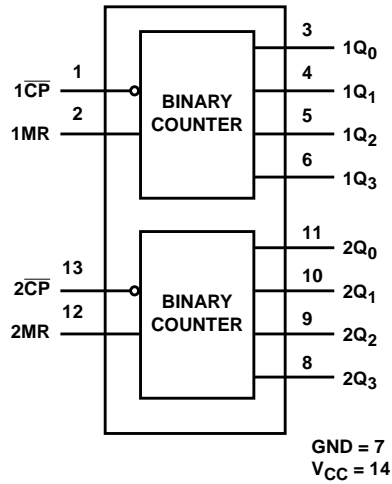
NOTE: When ordering, use the entire part number. The suffix 96 denotes tape and reel. The suffix T denotes a small-quantity reel of 250.

Pinout

CD54HC393, CD54HCT393
(CERDIP)
CD74HC393, CD74HCT393
(PDIP, SOIC)
TOP VIEW



Functional Diagram



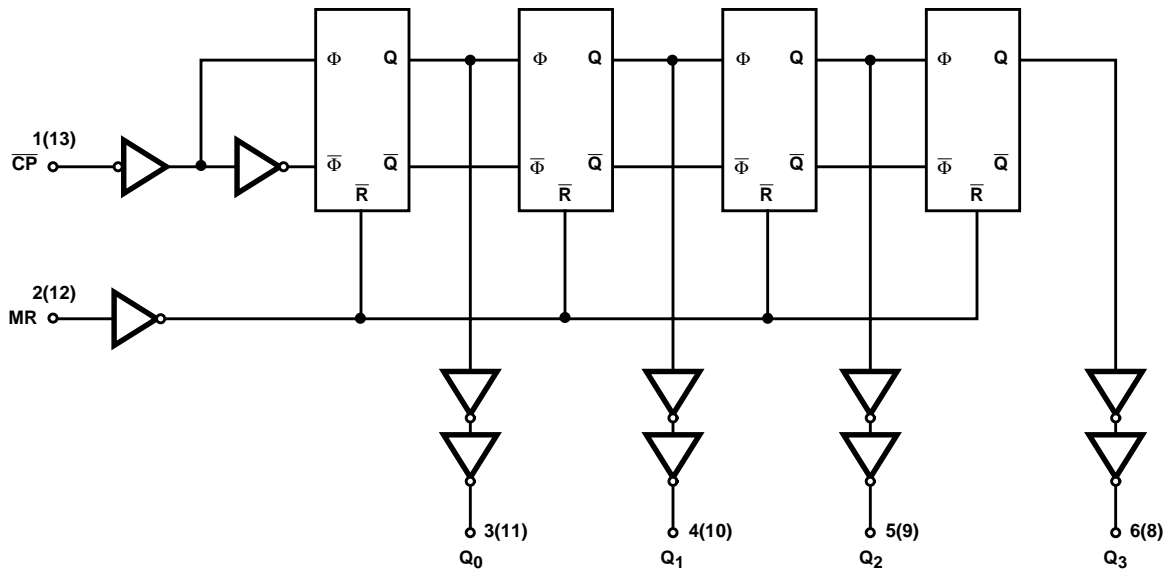
TRUTH TABLE

| CP COUNT | OUTPUTS | | | |
|----------|---------|-------|-------|-------|
| | Q_0 | Q_1 | Q_2 | Q_3 |
| 0 | L | L | L | L |
| 1 | H | L | L | L |
| 2 | L | H | L | L |
| 3 | H | H | L | L |
| 4 | L | L | H | L |
| 5 | H | L | H | L |
| 6 | L | H | H | L |
| 7 | H | H | H | L |
| 8 | L | L | L | H |
| 9 | H | L | L | H |
| 10 | L | H | L | H |
| 11 | H | H | L | H |
| 12 | L | L | H | H |
| 13 | H | L | H | H |
| 14 | L | H | H | H |
| 15 | H | H | H | H |

| CP COUNT | MR | OUTPUT |
|----------|----|-----------|
| ↑ | L | No Change |
| ↓ | L | Count |
| X | H | L L L L |

H = High Voltage Level, L = Low Voltage Level, X = Don't Care,
 ↑ = Transition from Low to High Level, ↓ = Transition from High to Low.

Logic Diagram



CD54HC393, CD74HC393, CD54HCT393, CD74HCT393

Absolute Maximum Ratings

| | |
|--|-------------|
| DC Supply Voltage, V_{CC} | -0.5V to 7V |
| DC Input Diode Current, I_{IK} | |
| For $V_I < -0.5V$ or $V_I > V_{CC} + 0.5V$ | $\pm 20mA$ |
| DC Output Diode Current, I_{OK} | |
| For $V_O < -0.5V$ or $V_O > V_{CC} + 0.5V$ | $\pm 20mA$ |
| DC Output Source or Sink Current per Output Pin, I_O | |
| For $V_O > -0.5V$ or $V_O < V_{CC} + 0.5V$ | $\pm 25mA$ |
| DC V_{CC} or Ground Current, I_{CC} or I_{GND} | $\pm 50mA$ |

Thermal Information

| | |
|--|--|
| Thermal Resistance (Typical, Note 1) | θ_{JA} ($^{\circ}C/W$) |
| E (PDIP) Package | 80 |
| M (SOIC) Package | 86 |
| Maximum Junction Temperature | 150 $^{\circ}C$ |
| Maximum Storage Temperature Range | -65 $^{\circ}C$ to 150 $^{\circ}C$ |
| Maximum Lead Temperature (Soldering 10s) | 300 $^{\circ}C$ (SOIC - Lead Tips Only) |

Operating Conditions

| | |
|---|------------------------------------|
| Temperature Range (T_A) | -55 $^{\circ}C$ to 125 $^{\circ}C$ |
| Supply Voltage Range, V_{CC} | |
| HC Types | .2V to 6V |
| HCT Types | .4.5V to 5.5V |
| DC Input or Output Voltage, V_I , V_O | 0V to V_{CC} |
| Input Rise and Fall Time | |
| 2V | 1000ns (Max) |
| 4.5V | 500ns (Max) |
| 6V | 400ns (Max) |

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

1. The package thermal impedance is calculated in accordance with JESD 51-7.

DC Electrical Specifications

| PARAMETER | SYMBOL | TEST CONDITIONS | | V_{CC} (V) | 25 $^{\circ}C$ | | | -40 $^{\circ}C$ TO 85 $^{\circ}C$ | | -55 $^{\circ}C$ TO 125 $^{\circ}C$ | | UNITS |
|---|----------|----------------------|------------|--------------|----------------|-----|-----------|-----------------------------------|---------|------------------------------------|---------|---------|
| | | V_I (V) | I_O (mA) | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| HC TYPES | | | | | | | | | | | | |
| High Level Input Voltage | V_{IH} | - | - | 2 | 1.5 | - | - | 1.5 | - | 1.5 | - | V |
| | | | | 4.5 | 3.15 | - | - | 3.15 | - | 3.15 | - | V |
| | | | | 6 | 4.2 | - | - | 4.2 | - | 4.2 | - | V |
| Low Level Input Voltage | V_{IL} | - | - | 2 | - | - | 0.5 | - | 0.5 | - | 0.5 | V |
| | | | | 4.5 | - | - | 1.35 | - | 1.35 | - | 1.35 | V |
| | | | | 6 | - | - | 1.8 | - | 1.8 | - | 1.8 | V |
| High Level Output Voltage CMOS Loads | V_{OH} | V_{IH} or V_{IL} | -0.02 | 2 | 1.9 | - | - | 1.9 | - | 1.9 | - | V |
| | | | -0.02 | 4.5 | 4.4 | - | - | 4.4 | - | 4.4 | - | V |
| | | | -0.02 | 6 | 5.9 | - | - | 5.9 | - | 5.9 | - | V |
| High Level Output Voltage TTL Loads | V_{OH} | V_{IH} or V_{IL} | - | - | - | - | - | - | - | - | - | V |
| | | | -4 | 4.5 | 3.98 | - | - | 3.84 | - | 3.7 | - | V |
| | | | -5.2 | 6 | 5.48 | - | - | 5.34 | - | 5.2 | - | V |
| Low Level Output Voltage CMOS Loads | V_{OL} | V_{IH} or V_{IL} | 0.02 | 2 | - | - | 0.1 | - | 0.1 | - | 0.1 | V |
| | | | 0.02 | 4.5 | - | - | 0.1 | - | 0.1 | - | 0.1 | V |
| | | | 0.02 | 6 | - | - | 0.1 | - | 0.1 | - | 0.1 | V |
| Low Level Output Voltage TTL Loads | V_{OL} | V_{IH} or V_{IL} | - | - | - | - | - | - | - | - | - | V |
| | | | 4 | 4.5 | - | - | 0.26 | - | 0.33 | - | 0.4 | V |
| | | | 5.2 | 6 | - | - | 0.26 | - | 0.33 | - | 0.4 | V |
| Input Leakage Current | I_I | V_{CC} or GND | - | 6 | - | - | ± 0.1 | - | ± 1 | - | ± 1 | μA |
| Quiescent Device Current | I_{CC} | V_{CC} or GND | 0 | 6 | - | - | 8 | - | 80 | - | 160 | μA |

CD54HC393, CD74HC393, CD54HCT393, CD74HCT393

DC Electrical Specifications (Continued)

| PARAMETER | SYMBOL | TEST CONDITIONS | | V _{CC} (V) | 25°C | | | -40°C TO 85°C | | -55°C TO 125°C | | UNITS |
|--|---------------------------|------------------------------------|---------------------|---------------------|------|-----|------|---------------|------|----------------|-----|-------|
| | | V _I (V) | I _O (mA) | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| HCT TYPES | | | | | | | | | | | | |
| High Level Input Voltage | V _{IH} | - | - | 4.5 to 5.5 | 2 | - | - | 2 | - | 2 | - | V |
| Low Level Input Voltage | V _{IL} | - | - | 4.5 to 5.5 | - | - | 0.8 | - | 0.8 | - | 0.8 | V |
| High Level Output Voltage CMOS Loads | V _{OH} | V _{IH} or V _{IL} | -0.02 | 4.5 | 4.4 | - | - | 4.4 | - | 4.4 | - | V |
| High Level Output Voltage TTL Loads | | | -4 | 4.5 | 3.98 | - | - | 3.84 | - | 3.7 | - | V |
| Low Level Output Voltage CMOS Loads | V _{OL} | V _{IH} or V _{IL} | 0.02 | 4.5 | - | - | 0.1 | - | 0.1 | - | 0.1 | V |
| Low Level Output Voltage TTL Loads | | | 4 | 4.5 | - | - | 0.26 | - | 0.33 | - | 0.4 | V |
| Input Leakage Current | I _I | V _{CC} and GND | 0 | 5.5 | - | - | ±0.1 | - | ±1 | - | ±1 | μA |
| Quiescent Device Current | I _{CC} | V _{CC} or GND | 0 | 5.5 | - | - | 8 | - | 80 | - | 160 | μA |
| Additional Quiescent Device Current Per Input Pin: 1 Unit Load | ΔI _{CC} (Note 2) | V _{CC} -2.1 | - | 4.5 to 5.5 | - | 100 | 360 | - | 450 | - | 490 | μA |

NOTE:

- For dual-supply systems theoretical worst case (V_I = 2.4V, V_{CC} = 5.5V) specification is 1.8mA.

HCT Input Loading Table

| INPUT | UNIT LOADS |
|-------|------------|
| nCP | 0.4 |
| nMR | 1 |

NOTE: Unit Load is ΔI_{CC} limit specified in DC Electrical Table, e.g., 360μA max at 25°C.

Prerequisite for Switching Specifications

| PARAMETER | SYMBOL | V _{CC} (V) | 25°C | | | -40°C TO 85°C | | -55°C TO 125°C | | UNITS |
|-------------------------|------------------|---------------------|------|-----|-----|---------------|-----|----------------|-----|-------|
| | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| HC TYPES | | | | | | | | | | |
| Maximum Clock Frequency | f _{MAX} | 2 | 6 | - | - | 5 | - | 4 | - | MHz |
| | | 4.5 | 30 | - | - | 24 | - | 20 | - | MHz |
| | | 6 | 35 | - | - | 28 | - | 24 | - | MHz |
| Clock Pulse Width | t _w | 2 | 80 | - | - | 100 | - | 120 | - | ns |
| | | 4.5 | 16 | - | - | 20 | - | 24 | - | ns |
| | | 6 | 14 | - | - | 17 | - | 20 | - | ns |

CD54HC393, CD74HC393, CD54HCT393, CD74HCT393

Prerequisite for Switching Specifications (Continued)

| PARAMETER | SYMBOL | V _{CC} (V) | 25°C | | | -40°C TO 85°C | | -55°C TO 125°C | | UNITS |
|-------------------------|------------------|---------------------|------|-----|-----|---------------|-----|----------------|-----|-------|
| | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| Reset Recovery Time | t _{REC} | 2 | 5 | - | - | 5 | - | 5 | - | ns |
| | | 4.5 | 5 | - | - | 5 | - | 5 | - | ns |
| | | 6 | 5 | - | - | 5 | - | 5 | - | ns |
| Reset Pulse Width | t _W | 2 | 80 | - | - | 100 | - | 120 | - | ns |
| | | 4.5 | 16 | - | - | 20 | - | 24 | - | ns |
| | | 6 | 14 | - | - | 17 | - | 20 | - | ns |
| HCT TYPES | | | | | | | | | | |
| Maximum Clock Frequency | f _{MAX} | 4.5 | 27 | - | - | 22 | - | 18 | - | MHz |
| Clock Pulse Width | t _W | 4.5 | 19 | - | - | 24 | - | 29 | - | ns |
| Reset Recovery Time | t _{REC} | 4.5 | 5 | - | - | 5 | - | 5 | - | ns |
| Reset Pulse Width | t _W | 4.5 | 16 | - | - | 20 | - | 24 | - | ns |

Switching Specifications Input t_r, t_f = 6ns

| PARAMETER | SYMBOL | TEST CONDITIONS | V _{CC} (V) | 25°C | | | -40°C TO 85°C | | -55°C TO 125°C | | UNITS |
|--|--|-----------------------|---------------------|------|-----|-----|---------------|-----|----------------|-----|-------|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| HC TYPES | | | | | | | | | | | |
| Propagation Delay Time (Figure 1) nCP to nQ ₀ | t _{PLH} , t _{PHL} | C _L = 50pF | 2 | - | - | 150 | - | 190 | - | 225 | ns |
| | | | 4.5 | - | - | 30 | - | 38 | - | 59 | ns |
| | | C _L = 15pF | 5 | - | 12 | - | - | - | - | - | ns |
| | | C _L = 50pF | 6 | - | - | 26 | - | 33 | - | 50 | ns |
| nCP to nQ ₁ | t _{PLH} , t _{PHL} | C _L = 50pF | 2 | - | - | 190 | - | 245 | - | 295 | ns |
| | | | 4.5 | - | - | 38 | - | 49 | - | 59 | ns |
| | | | 6 | - | - | 33 | - | 42 | - | 50 | ns |
| nCP to nQ ₂ | t _{PLH} , t _{PHL} | C _L = 50pF | 2 | - | - | 240 | - | 300 | - | 360 | ns |
| | | | 4.5 | - | - | 48 | - | 60 | - | 72 | ns |
| | | | 6 | - | - | 41 | - | 51 | - | 61 | ns |
| nCP to nQ ₃ | t _{PLH} , t _{PHL} | C _L = 50pF | 2 | - | - | 285 | - | 355 | - | 430 | ns |
| | | | 4.5 | - | - | 57 | - | 71 | - | 86 | ns |
| | | | 6 | - | - | 48 | - | 60 | - | 73 | ns |
| MR to Q _n | t _{PLH} , t _{PHL} | C _L = 50pF | 2 | - | - | 135 | - | 170 | - | 205 | ns |
| | | | 4.5 | - | - | 27 | - | 34 | - | 41 | ns |
| | | C _L = 15pF | 5 | - | 11 | - | - | - | - | - | ns |
| | | C _L = 50pF | 6 | - | - | 23 | - | 29 | - | 35 | ns |
| Output Transition Time (Figure 1) | t _{TLH} , t _{THL} | C _L = 50pF | 2 | - | - | 75 | - | 95 | - | 110 | ns |
| | | | 4.5 | - | - | 15 | - | 19 | - | 22 | ns |
| | | | 6 | - | - | 13 | - | 16 | - | 19 | ns |
| Input Capacitance | C _{IN} | C _L = 50pF | - | - | - | 10 | - | 10 | - | pF | |
| Power Dissipation Capacitance (Notes 3, 4) | C _{PD} | C _L = 15pF | 5 | - | 20 | - | - | - | - | pF | |

CD54HC393, CD74HC393, CD54HCT393, CD74HCT393

Switching Specifications Input $t_r, t_f = 6\text{ns}$ (Continued)

| PARAMETER | SYMBOL | TEST CONDITIONS | V_{CC} (V) | 25°C | | | -40°C TO 85°C | | -55°C TO 125°C | | UNITS |
|---|--------------------|---------------------|-----------------|------|-----|-----|---------------|-----|----------------|-----|-------|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| HCT TYPES | | | | | | | | | | | |
| Propagation Delay Time (Figure 1) | t_{PLH}, t_{PHL} | $C_L = 50\text{pF}$ | 4.5 | - | - | 32 | - | 40 | - | 48 | ns |
| | | $C_L = 15\text{pF}$ | 5 | - | 13 | - | - | - | - | - | ns |
| $n\overline{CP}$ to nQ_0 | t_{PLH}, t_{PHL} | $C_L = 50\text{pF}$ | 4.5 | - | - | 44 | - | 55 | - | 66 | ns |
| $n\overline{CP}$ to nQ_2 | t_{PLH}, t_{PHL} | $C_L = 50\text{pF}$ | 4.5 | - | - | 50 | - | 63 | - | 75 | ns |
| $n\overline{CP}$ to nQ_3 | t_{PLH}, t_{PHL} | $C_L = 50\text{pF}$ | 4.5 | - | - | 62 | - | 78 | - | 93 | ns |
| MR to Q_n | t_{PLH}, t_{PHL} | $C_L = 50\text{pF}$ | 4.5 | - | - | 32 | - | 40 | - | 48 | ns |
| | | $C_L = 15\text{pF}$ | 5 | - | 13 | - | - | - | - | - | ns |
| Output Transition | t_{TLH}, t_{THL} | $C_L = 50\text{pF}$ | 4.5 | - | - | 15 | - | 19 | - | 22 | ns |
| Input Capacitance | C_{IN} | $C_L = 15\text{pF}$ | - | - | - | 10 | - | 10 | - | 10 | pF |
| Power Dissipation Capacitance (Notes 3, 4) | C_{PD} | $C_L = 15\text{pF}$ | 5 | - | 21 | - | - | - | - | - | pF |

NOTES:

- C_{PD} is used to determine the dynamic power consumption, per stage.
- $P_D = V_{CC}^2 f_i (C_{PD} + C_L)$ where f_i = Input Frequency, C_L = Output Load Capacitance, V_{CC} = Supply Voltage.

Test Circuits and Waveforms

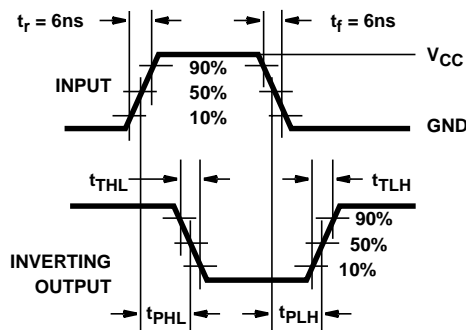


FIGURE 1. HC AND HCU TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

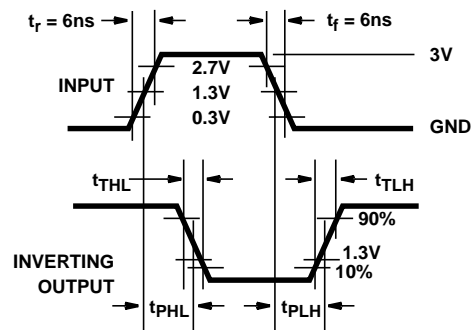


FIGURE 2. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

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) |



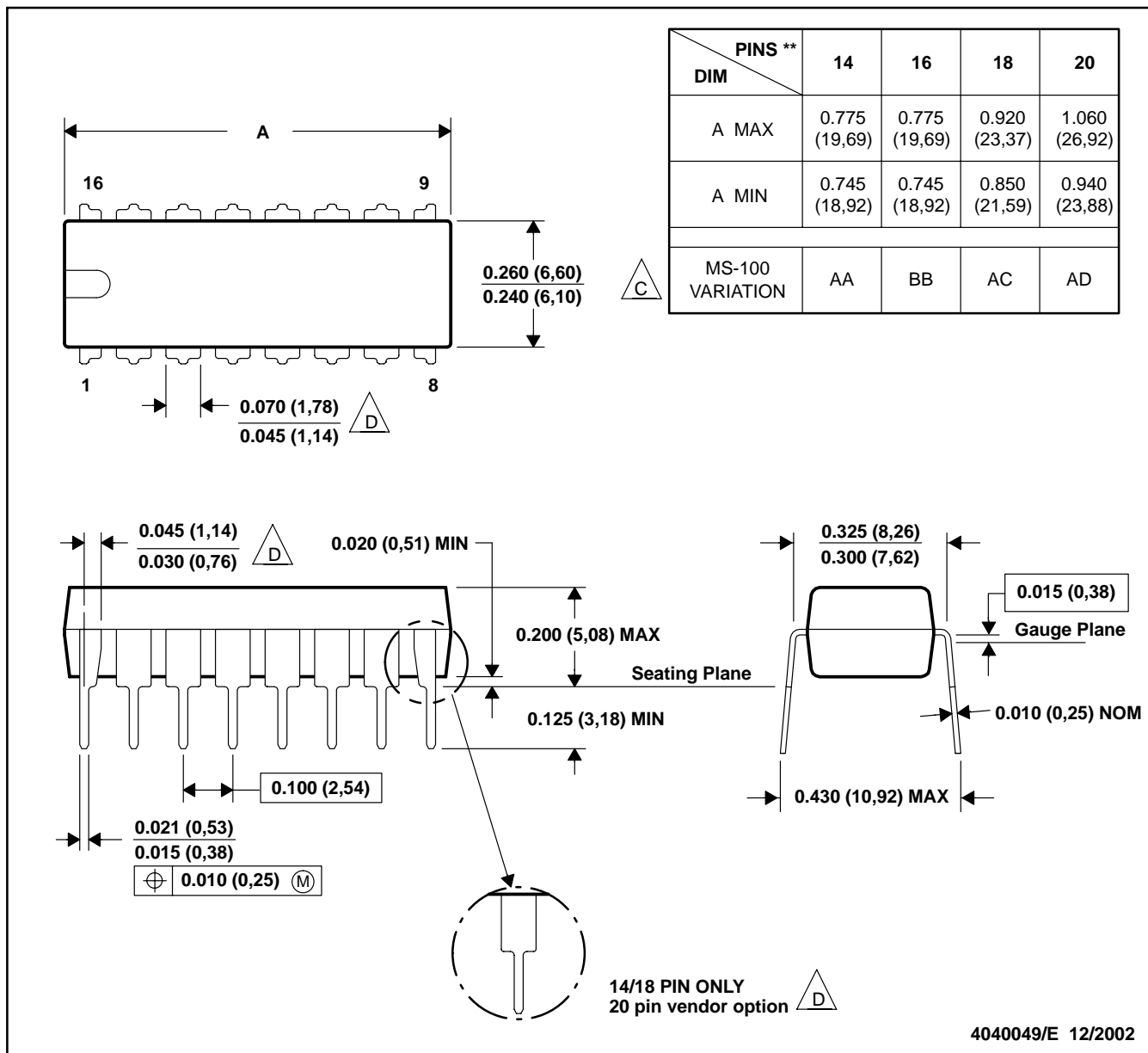
4040083/F 03/03

- NOTES:
- 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.

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



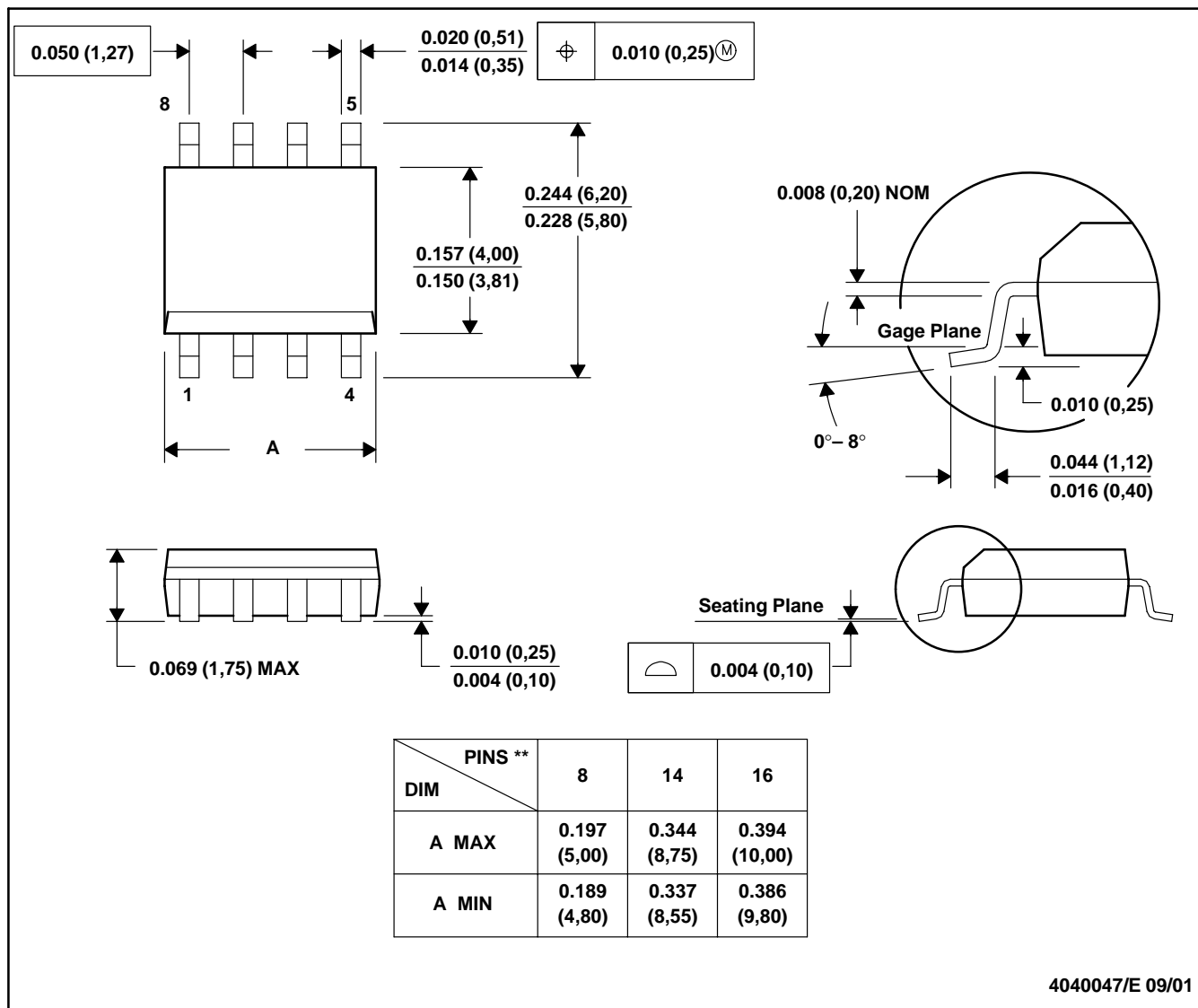
- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 D The 20 pin end lead shoulder width is a vendor option, either half or full width.

4040049/E 12/2002

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

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