

High-Speed CMOS Logic Hex D-Type Flip-Flop with Reset

Features

- Buffered Positive Edge Triggered Clock
- Asynchronous Common Reset
- 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 'HC174 and 'HCT174 are edge triggered flip-flops which utilize silicon gate CMOS circuitry to implement D-type flip-flops. They possess low power and speeds comparable to low power Schottky TTL circuits. The devices contain six master-slave flip-flops with a common clock and common reset. Data on the D input having the specified setup and hold

times is transferred to the Q output on the low to high transition of the CLOCK input. The MR input, when low, sets all outputs to a low state.

Each output can drive ten low power Schottky TTL equivalent loads. The 'HCT174 is functional as well as, pin compatible to the 'LS174.

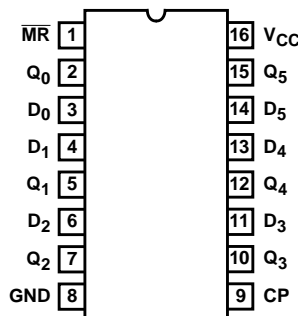
Ordering Information

| PART NUMBER | TEMP. RANGE (°C) | PACKAGE |
|---------------|------------------|--------------|
| CD54HC174F3A | -55 to 125 | 16 Ld CERDIP |
| CD54HCT174F3A | -55 to 125 | 16 Ld CERDIP |
| CD74HC174E | -55 to 125 | 16 Ld PDIP |
| CD74HC174M | -55 to 125 | 16 Ld SOIC |
| CD74HC174MT | -55 to 125 | 16 Ld SOIC |
| CD74HC174M96 | -55 to 125 | 16 Ld SOIC |
| CD74HCT174E | -55 to 125 | 16 Ld PDIP |
| CD74HCT174M | -55 to 125 | 16 Ld SOIC |
| CD74HCT174MT | -55 to 125 | 16 Ld SOIC |
| CD74HCT174M96 | -55 to 125 | 16 Ld SOIC |

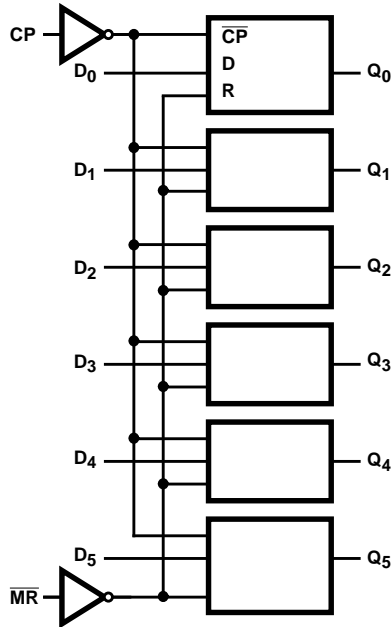
NOTE: When ordering, use the entire part number. The suffix 96 denotes tape and reel. The suffix T denotes a small-quantity reel of 250.

Pinout

CD54HC174, CD54HCT174
(CERDIP)
CD74HC174, CD74HCT174
(PDIP, SOIC)
TOP VIEW



Functional Diagram

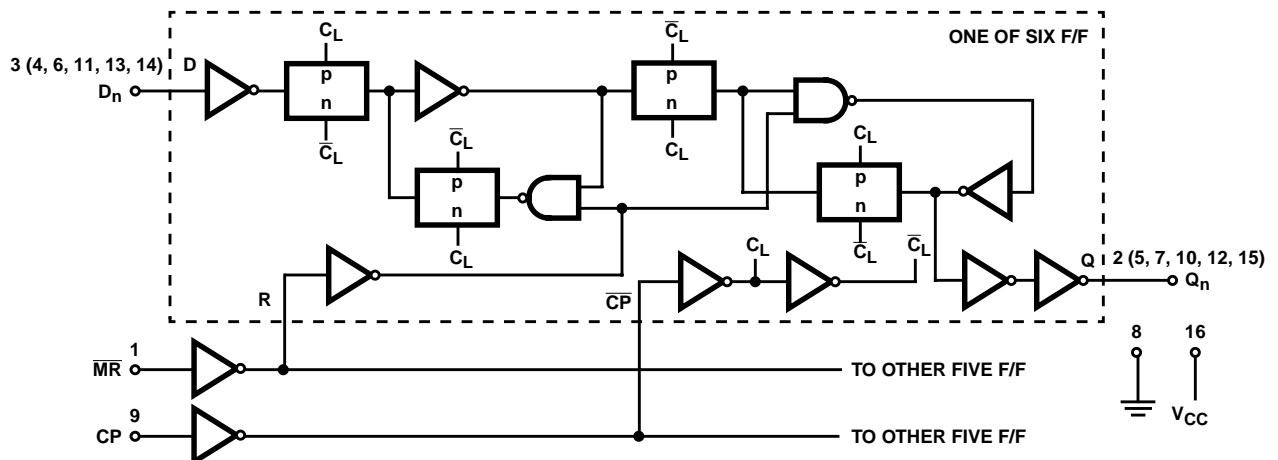


TRUTH TABLE

| INPUTS | | | OUTPUT |
|---------------------------|------------|------------|--------|
| RESET (\overline{MR}) | CLOCK CP | DATA D_n | Q_n |
| L | X | X | L |
| H | \uparrow | H | H |
| H | \uparrow | L | L |
| H | L | X | Q_0 |

H = High Voltage Level, L = Low Voltage Level, X = Irrelevant, \uparrow = Transition from Low to High Level, Q_0 = Level Before the Indicated Steady-State Input Conditions Were Established

Logic Diagram



CD54HC174, CD74HC174, CD54HCT174, CD74HCT174

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 | 67 |
| M (SOIC) Package | 73 |
| 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:

- 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 |
| | | | -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 |
| | | | 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 |

CD54HC174, CD74HC174, CD54HCT174, CD74HCT174

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} to 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 |
|-------|------------|
| CP | 0.80 |
| MR | 0.55 |
| D | 0.15 |

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

Prerequisite For Switching Function

| PARAMETER | SYMBOL | TEST CONDITIONS | V _{CC} (V) | 25°C | | -40°C TO 85°C | | -55°C TO 125°C | | UNITS |
|-------------------|----------------|-----------------|---------------------|------|-----|---------------|-----|----------------|-----|-------|
| | | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| HC TYPES | | | | | | | | | | |
| Clock Pulse Width | t _w | - | 2 | 80 | - | 100 | - | 120 | - | ns |
| | | | 4.5 | 16 | - | 20 | - | 24 | - | ns |
| | | | 6 | 14 | - | 17 | - | 20 | - | ns |
| MR Pulse Width | t _w | - | 2 | 80 | - | 100 | - | 120 | - | ns |
| | | | 4.5 | 16 | - | 20 | - | 24 | - | ns |
| | | | 6 | 14 | - | 17 | - | 20 | - | ns |

CD54HC174, CD74HC174, CD54HCT174, CD74HCT174

Prerequisite For Switching Function (Continued)

| PARAMETER | SYMBOL | TEST CONDITIONS | V _{CC} (V) | 25°C | | -40°C TO 85°C | | -55°C TO 125°C | | UNITS |
|--|------------------|-----------------|---------------------|------|-----|---------------|-----|----------------|-----|-------|
| | | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| Setup Time, Data to Clock | t _{SU} | - | 2 | 60 | - | 75 | - | 90 | - | ns |
| | | | 4.5 | 12 | - | 15 | - | 18 | - | ns |
| | | | 6 | 10 | - | 13 | - | 15 | - | ns |
| Hold Time, Data to Clock | t _H | - | 2 | 5 | - | 5 | - | 5 | - | ns |
| | | | 4.5 | 5 | - | 5 | - | 5 | - | ns |
| | | | 6 | 5 | - | 5 | - | 5 | - | ns |
| Removal Time, \overline{MR} to Clock | t _{REM} | - | 2 | 5 | - | 5 | - | 5 | - | ns |
| | | | 4.5 | 5 | - | 5 | - | 5 | - | ns |
| | | | 6 | 5 | - | 5 | - | 5 | - | ns |
| Clock Frequency | f _{MAX} | - | 2 | 6 | - | 5 | - | 4 | - | MHz |
| | | | 4.5 | 30 | - | 24 | - | 20 | - | MHz |
| | | | 6 | 35 | - | 28 | - | 24 | - | MHz |

HCT TYPES

| | | | | | | | | | | |
|--|------------------|---|-----|----|---|----|---|----|---|-----|
| Clock Pulse Width | t _w | - | 4.5 | 20 | - | 25 | - | 30 | - | ns |
| \overline{MR} Pulse Width | t _w | - | 6 | 25 | - | 31 | - | 38 | - | ns |
| Setup Time, Data to Clock | t _{SU} | - | 4.5 | 16 | - | 20 | - | 24 | - | ns |
| Hold Time, Data to Clock | t _H | - | 6 | 5 | - | 5 | - | 5 | - | ns |
| Removal Time, \overline{MR} to Clock | t _{REM} | - | 4.5 | 12 | - | 15 | - | 18 | - | ns |
| Clock Frequency | f _{MAX} | - | 6 | 25 | - | 20 | - | 17 | - | MHz |

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 |
|--|-------------------------------------|-----------------------|---------------------|------|-----|---------------|----------------|-------|
| | | | | TYP | MAX | MAX | MAX | |
| Propagation Delay, Clock to Q | t _{PLH} , t _{PHL} | C _L = 50pF | 2 | - | 165 | 205 | 250 | ns |
| | | | 4.5 | - | 33 | 41 | 50 | ns |
| | | | 6 | - | 28 | 35 | 43 | ns |
| | | C _L = 15pF | 5 | 13 | - | - | - | ns |
| Propagation Delay, \overline{MR} to Q | t _{PLH} , t _{PHL} | C _L = 50pF | 2 | - | 150 | 190 | 225 | ns |
| | | | 4.5 | - | 30 | 38 | 45 | ns |
| | | | 6 | - | 26 | 33 | 38 | ns |
| | | C _L = 15pF | 5 | 12 | - | - | - | ns |
| Output Transition Times | 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} | - | - | - | 10 | 10 | 10 | pF |
| Power Dissipation Capacitance (Notes 3, 4) | C _{PD} | - | 5 | 38 | - | - | - | pF |

CD54HC174, CD74HC174, CD54HCT174, CD74HCT174

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 |
|--|--------------------|---------------------|--------------|------|-----|---------------|----------------|-------|
| | | | | TYP | MAX | MAX | MAX | |
| HCT TYPES | | | | | | | | |
| Propagation Delay, Clock to Q | t_{PLH}, t_{PHL} | $C_L = 50\text{pF}$ | 4.5 | - | 40 | 50 | 60 | ns |
| | | | 5 | 17 | - | - | - | ns |
| Propagation Delay, \overline{MR} to Q | t_{PLH}, t_{PHL} | $C_L = 50\text{pF}$ | 4.5 | - | 44 | 55 | 66 | ns |
| | | | 5 | 18 | - | - | - | ns |
| Output Transition Times | t_{TLH}, t_{THL} | $C_L = 50\text{pF}$ | 4.5 | - | 15 | 19 | 22 | ns |
| Input Capacitance | C_{IN} | - | - | - | 10 | 10 | 10 | pF |
| Power Dissipation Capacitance (Notes 3, 4) | C_{PD} | - | 5 | 44 | - | - | - | pF |

NOTES:

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

Test Circuits and Waveforms

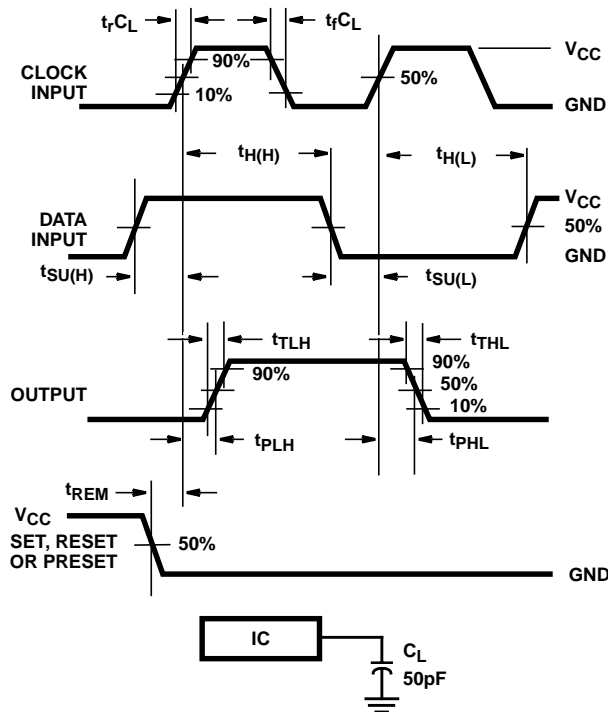


FIGURE 1. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

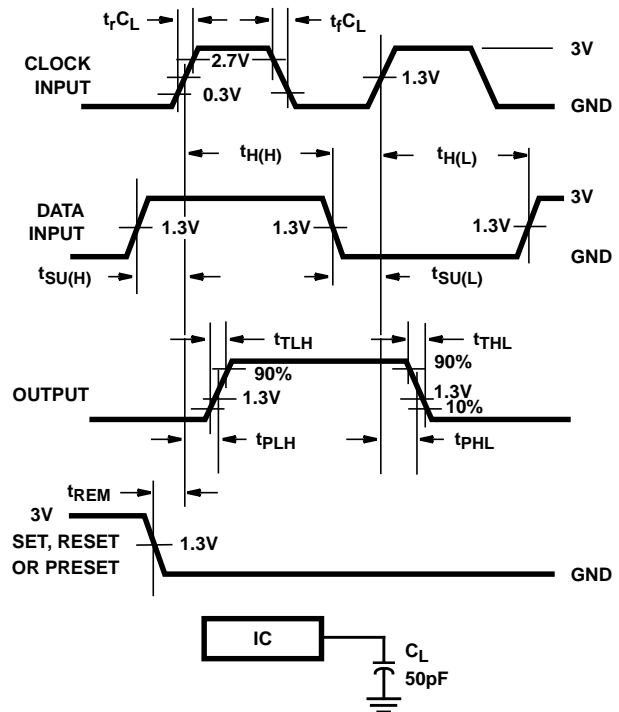


FIGURE 2. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

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) |



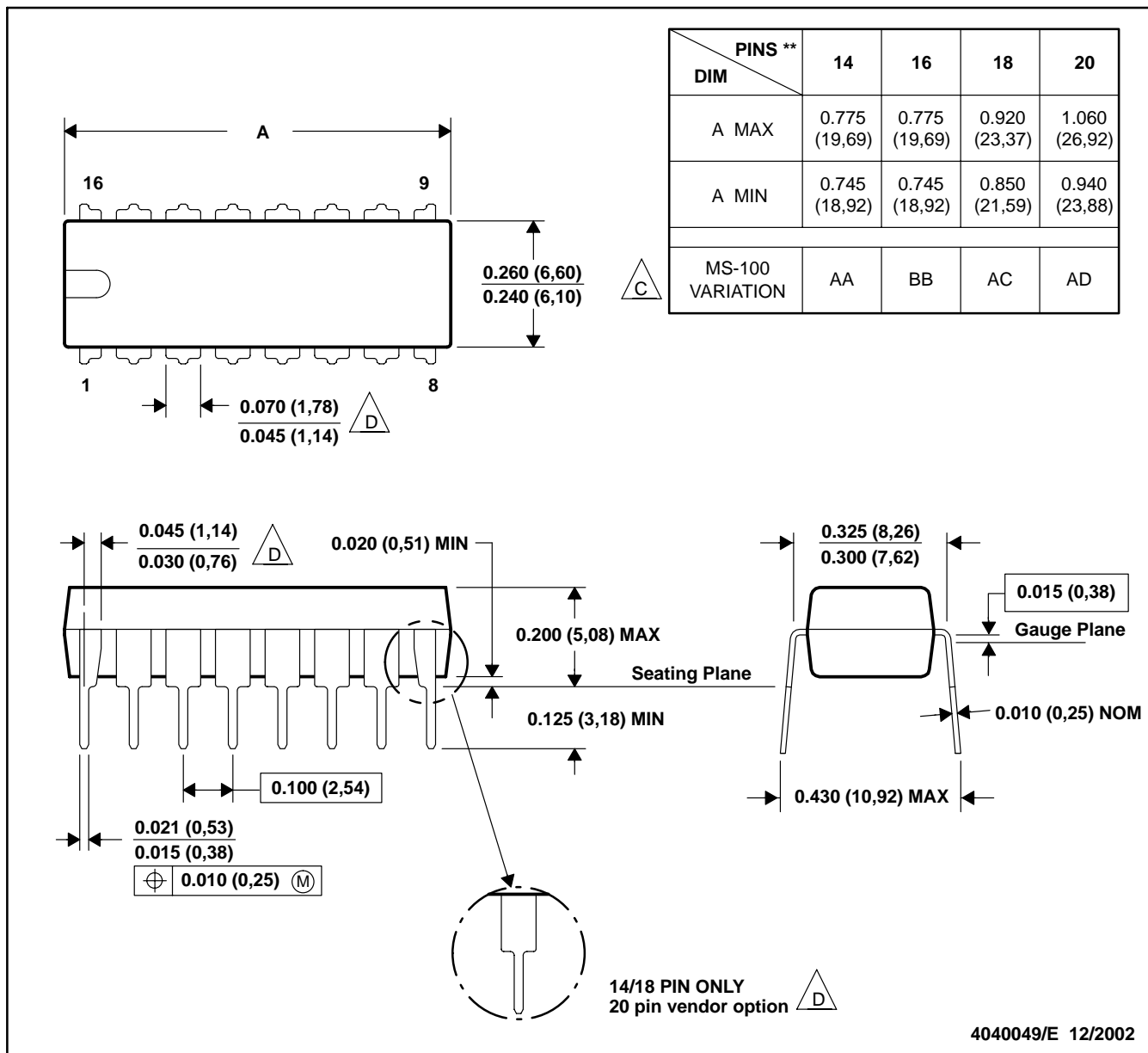
4040083/F 03/03

- 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.

D (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

8 PINS SHOWN



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

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

| Products | | Applications | |
|------------------|--|---------------------|--|
| Amplifiers | amplifier.ti.com | Audio | www.ti.com/audio |
| Data Converters | dataconverter.ti.com | Automotive | www.ti.com/automotive |
| DSP | dsp.ti.com | Broadband | www.ti.com/broadband |
| Interface | interface.ti.com | Digital Control | www.ti.com/digitalcontrol |
| Logic | logic.ti.com | Military | www.ti.com/military |
| Power Mgmt | power.ti.com | Optical Networking | www.ti.com/opticalnetwork |
| Microcontrollers | microcontroller.ti.com | Security | www.ti.com/security |
| | | Telephony | www.ti.com/telephony |
| | | Video & Imaging | www.ti.com/video |
| | | Wireless | www.ti.com/wireless |

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265

Copyright © 2003, Texas Instruments Incorporated