

September 1998 - Revised May 2000

## Hex D Flip-Flop with Reset

### Features

- Buffered Inputs
- Typical Propagation Delay
  - 6.4ns at  $V_{CC} = 5V$ ,  $T_A = 25^{\circ}C$ ,  $C_L = 50pF$
- Exceeds 2kV ESD Protection MIL-STD-883, Method 3015
- SCR-Latchup-Resistant CMOS Process and Circuit Design
- Speed of Bipolar FAST™/AS/S with Significantly Reduced Power Consumption
- Balanced Propagation Delays
- AC Types Feature 1.5V to 5.5V Operation and Balanced Noise Immunity at 30% of the Supply
- $\pm 24mA$  Output Drive Current
  - Fanout to 15 FAST™ ICs
  - Drives 50 $\Omega$  Transmission Lines

### Description

The CD74AC174 and 'ACT174 are hex D flip-flops with reset that utilize Advanced CMOS Logic technology. Information at the D input is transferred to the Q output on the positive-going edge of the clock pulse. All six flip-flops are controlled by a common clock (CP) and a common reset ( $\overline{MR}$ ). Resetting is accomplished by a low voltage level independent of the clock.

### Ordering Information

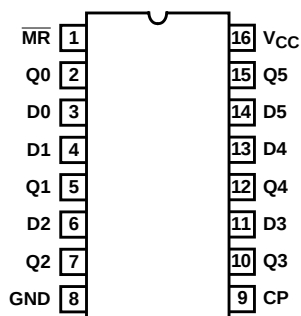
| PART NUMBER   | TEMP. RANGE ( $^{\circ}C$ ) | PACKAGE      |
|---------------|-----------------------------|--------------|
| CD74AC174E    | -55 to 125                  | 16 Ld PDIP   |
| CD74AC174M    | -55 to 125                  | 16 Ld SOIC   |
| CD54ACT174F3A | -55 to 125                  | 16 Ld CERDIP |
| CD74ACT174E   | -55 to 125                  | 16 Ld PDIP   |
| CD74ACT174M   | -55 to 125                  | 16 Ld SOIC   |

#### NOTES:

1. When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.
2. Wafer and die for this part number is available which meets all electrical specifications. Please contact your local TI sales office or customer service for ordering information.

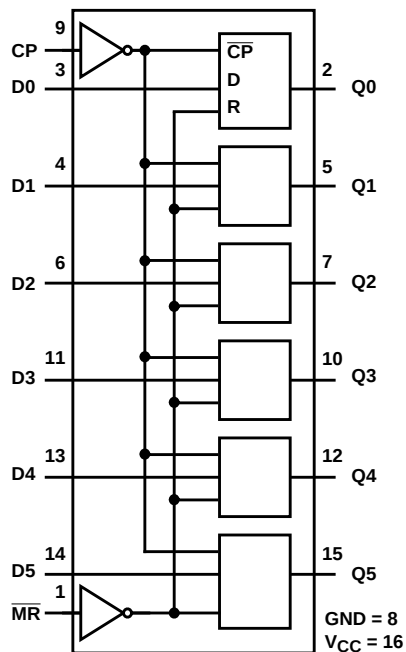
### Pinout

CD54ACT174  
(CERDIP)  
CD74AC174, CD74ACT174  
(PDIP, SOIC)  
TOP VIEW



CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper IC Handling Procedures.

## Functional Diagram



TRUTH TABLE (EACH FLIP-FLOP)

| INPUTS        |             |            | OUTPUTS |
|---------------|-------------|------------|---------|
| RESET<br>(MR) | CLOCK<br>CP | DATA<br>Dn | Qn      |
| L             | X           | X          | L       |
| H             | ↑           | H          | H       |
| H             | ↑           | L          | L       |
| H             | L           | X          | Q0      |

H = High Level (Steady State)

L = Low Level (Steady State)

X = Irrelevant

↑ = Transition from Low to High level

Q0 = Level before the Indicated Steady-State Input conditions were established.

# CD74AC174, CD54/74ACT174

## Absolute Maximum Ratings

DC Supply Voltage,  $V_{CC}$  ..... -0.5V to 6V  
 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  $V_O > V_{CC} + 0.5V$  .....  $\pm 50mA$   
 DC Output Source or Sink Current per Output Pin,  $I_O$   
     For  $V_O > -0.5V$  or  $V_O < V_{CC} + 0.5V$  .....  $\pm 50mA$   
 DC  $V_{CC}$  or Ground Current,  $I_{CC}$  or  $I_{GND}$  (Note 3) .....  $\pm 100mA$

## Thermal Information

Thermal Resistance (Typical, Note 5)  $\theta_{JA}$  ( $^{\circ}C/W$ )  
 PDIP Package ..... 90  
 SOIC Package ..... 160  
 Maximum Junction Temperature (Plastic Package) .....  $150^{\circ}C$   
 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,  $V_{CC}$  (Note 4)  
     AC Types ..... 1.5V to 5.5V  
     ACT Types ..... 4.5V to 5.5V  
 DC Input or Output Voltage,  $V_I$ ,  $V_O$  ..... 0V to  $V_{CC}$   
 Input Rise and Fall Slew Rate,  $dt/dv$   
     AC Types, 1.5V to 3V ..... 50ns (Max)  
     AC Types, 3.6V to 5.5V ..... 20ns (Max)  
     ACT Types, 4.5V to 5.5V ..... 10ns (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.

### NOTES:

- For up to 4 outputs per device, add  $\pm 25mA$  for each additional output.
- Unless otherwise specified, all voltages are referenced to ground.
- $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

## DC Electrical Specifications

| PARAMETER                 | SYMBOL          | TEST CONDITIONS                    |                     | V <sub>CC</sub><br>(V) | 25°C |      | -40°C TO 85°C |      | -55°C TO 125°C |      | UNITS |
|---------------------------|-----------------|------------------------------------|---------------------|------------------------|------|------|---------------|------|----------------|------|-------|
|                           |                 | V <sub>I</sub> (V)                 | I <sub>O</sub> (mA) |                        | MIN  | MAX  | MIN           | MAX  | MIN            | MAX  |       |
| AC TYPES                  |                 |                                    |                     |                        |      |      |               |      |                |      |       |
| High Level Input Voltage  | V <sub>IH</sub> | -                                  | -                   | 1.5                    | 1.2  | -    | 1.2           | -    | 1.2            | -    | V     |
|                           |                 |                                    |                     | 3                      | 2.1  | -    | 2.1           | -    | 2.1            | -    | V     |
|                           |                 |                                    |                     | 5.5                    | 3.85 | -    | 3.85          | -    | 3.85           | -    | V     |
| Low Level Input Voltage   | V <sub>IL</sub> | -                                  | -                   | 1.5                    | -    | 0.3  | -             | 0.3  | -              | 0.3  | V     |
|                           |                 |                                    |                     | 3                      | -    | 0.9  | -             | 0.9  | -              | 0.9  | V     |
|                           |                 |                                    |                     | 5.5                    | -    | 1.65 | -             | 1.65 | -              | 1.65 | V     |
| High Level Output Voltage | V <sub>OH</sub> | V <sub>IH</sub> or V <sub>IL</sub> | -0.05               | 1.5                    | 1.4  | -    | 1.4           | -    | 1.4            | -    | V     |
|                           |                 |                                    | -0.05               | 3                      | 2.9  | -    | 2.9           | -    | 2.9            | -    | V     |
|                           |                 |                                    | -0.05               | 4.5                    | 4.4  | -    | 4.4           | -    | 4.4            | -    | V     |
|                           |                 |                                    | -4                  | 3                      | 2.58 | -    | 2.48          | -    | 2.4            | -    | V     |
|                           |                 |                                    | -24                 | 4.5                    | 3.94 | -    | 3.8           | -    | 3.7            | -    | V     |
|                           |                 |                                    | -75<br>(Note 6, 7)  | 5.5                    | -    | -    | 3.85          | -    | -              | -    | V     |
|                           |                 |                                    | -50<br>(Note 6, 7)  | 5.5                    | -    | -    | -             | -    | 3.85           | -    | V     |

# CD74AC174, CD54/74ACT174

## DC Electrical Specifications (Continued)

| PARAMETER                                                           | SYMBOL           | TEST CONDITIONS                    |                     | V <sub>CC</sub> (V) | 25°C |      | -40°C TO 85°C |      | -55°C TO 125°C |      | UNITS |
|---------------------------------------------------------------------|------------------|------------------------------------|---------------------|---------------------|------|------|---------------|------|----------------|------|-------|
|                                                                     |                  | V <sub>I</sub> (V)                 | I <sub>O</sub> (mA) |                     | MIN  | MAX  | MIN           | MAX  | MIN            | MAX  |       |
| Low Level Output Voltage                                            | V <sub>OL</sub>  | V <sub>IH</sub> or V <sub>IL</sub> | 0.05                | 1.5                 | -    | 0.1  | -             | 0.1  | -              | 0.1  | V     |
|                                                                     |                  |                                    | 0.05                | 3                   | -    | 0.1  | -             | 0.1  | -              | 0.1  | V     |
|                                                                     |                  |                                    | 0.05                | 4.5                 | -    | 0.1  | -             | 0.1  | -              | 0.1  | V     |
|                                                                     |                  |                                    | 12                  | 3                   | -    | 0.36 | -             | 0.44 | -              | 0.5  | V     |
|                                                                     |                  |                                    | 24                  | 4.5                 | -    | 0.36 | -             | 0.44 | -              | 0.5  | V     |
|                                                                     |                  |                                    | 75<br>(Note 6, 7)   | 5.5                 | -    | -    | -             | 1.65 | -              | -    | V     |
|                                                                     |                  |                                    | 50<br>(Note 6, 7)   | 5.5                 | -    | -    | -             | -    | -              | 1.65 | V     |
| Input Leakage Current                                               | I <sub>I</sub>   | V <sub>CC</sub> or GND             | -                   | 5.5                 | -    | ±0.1 | -             | ±1   | -              | ±1   | μA    |
| Quiescent Supply Current MSI                                        | I <sub>CC</sub>  | V <sub>CC</sub> or GND             | 0                   | 5.5                 | -    | 8    | -             | 80   | -              | 160  | μA    |
| <b>ACT TYPES</b>                                                    |                  |                                    |                     |                     |      |      |               |      |                |      |       |
| High Level Input Voltage                                            | V <sub>IH</sub>  | -                                  | -                   | 4.5 to 5.5          | 2    | -    | 2             | -    | 2              | -    | V     |
| Low Level Input Voltage                                             | V <sub>IL</sub>  | -                                  | -                   | 4.5 to 5.5          | -    | 0.8  | -             | 0.8  | -              | 0.8  | V     |
| High Level Output Voltage                                           | V <sub>OH</sub>  | V <sub>IH</sub> or V <sub>IL</sub> | -0.05               | 4.5                 | 4.4  | -    | 4.4           | -    | 4.4            | -    | V     |
|                                                                     |                  |                                    | -24                 | 4.5                 | 3.94 | -    | 3.8           | -    | 3.7            | -    | V     |
|                                                                     |                  |                                    | -75<br>(Note 6, 7)  | 5.5                 | -    | -    | 3.85          | -    | -              | -    | V     |
|                                                                     |                  |                                    | -50<br>(Note 6, 7)  | 5.5                 | -    | -    | -             | -    | 3.85           | -    | V     |
| Low Level Output Voltage                                            | V <sub>OL</sub>  | V <sub>IH</sub> or V <sub>IL</sub> | 0.05                | 4.5                 | -    | 0.1  | -             | 0.1  | -              | 0.1  | V     |
|                                                                     |                  |                                    | 24                  | 4.5                 | -    | 0.36 | -             | 0.44 | -              | 0.5  | V     |
|                                                                     |                  |                                    | 75<br>(Note 6, 7)   | 5.5                 | -    | -    | -             | 1.65 | -              | -    | V     |
|                                                                     |                  |                                    | 50<br>(Note 6, 7)   | 5.5                 | -    | -    | -             | -    | -              | 1.65 | V     |
| Input Leakage Current                                               | I <sub>I</sub>   | V <sub>CC</sub> or GND             | -                   | 5.5                 | -    | ±0.1 | -             | ±1   | -              | ±1   | μA    |
| Quiescent Supply Current MSI                                        | I <sub>CC</sub>  | V <sub>CC</sub> or GND             | 0                   | 5.5                 | -    | 8    | -             | 80   | -              | 160  | μA    |
| Additional Supply Current per Input Pin TTL Inputs High 1 Unit Load | ΔI <sub>CC</sub> | V <sub>CC</sub> -2.1               | -                   | 4.5 to 5.5          | -    | 2.4  | -             | 2.8  | -              | 3    | mA    |

### NOTES:

- Test one output at a time for a 1-second maximum duration. Measurement is made by forcing current and measuring voltage to minimize power dissipation.
- Test verifies a minimum 50Ω transmission-line-drive capability at 85°C, 75Ω at 125°C.

### ACT Input Load Table

| INPUT  | UNIT LOAD |
|--------|-----------|
| Dn, MR | 0.5       |
| CP     | 0.83      |

NOTE: Unit load is ΔI<sub>CC</sub> limit specified in DC Electrical Specifications Table, e.g., 2.4mA max at 25°C.

# CD74AC174, CD54/74ACT174

## Prerequisite For Switching Function

| PARAMETER                                  | SYMBOL           | V <sub>CC</sub> (V) | -40°C TO 85°C |     | -55°C TO 125°C |     | UNITS |
|--------------------------------------------|------------------|---------------------|---------------|-----|----------------|-----|-------|
|                                            |                  |                     | MIN           | MAX | MIN            | MAX |       |
| AC TYPES                                   |                  |                     |               |     |                |     |       |
| Data to CP Set-Up Time                     | t <sub>SU</sub>  | 1.5                 | 2             | -   | 2              | -   | ns    |
|                                            |                  | 3.3<br>(Note 9)     | 2             | -   | 2              | -   | ns    |
|                                            |                  | 5<br>(Note 10)      | 2             | -   | 2              | -   | ns    |
| Hold Time                                  | t <sub>H</sub>   | 1.5                 | 33            | -   | 38             | -   | ns    |
|                                            |                  | 3.3                 | 3.7           | -   | 4.2            | -   | ns    |
|                                            |                  | 5                   | 2.6           | -   | 3              | -   | ns    |
| Removal Time, $\overline{\text{MR}}$ to CP | t <sub>REM</sub> | 1.5                 | 1.5           | -   | 1.5            | -   | ns    |
|                                            |                  | 3.3                 | 1.5           | -   | 1.5            | -   | ns    |
|                                            |                  | 5                   | 1.5           | -   | 1.5            | -   | ns    |
| $\overline{\text{MR}}$ Pulse Width         | t <sub>W</sub>   | 1.5                 | 44            | -   | 50             | -   | ns    |
|                                            |                  | 3.3                 | 4.9           | -   | 5.6            | -   | ns    |
|                                            |                  | 5                   | 3.5           | -   | 4              | -   | ns    |
| CP Pulse Width                             | t <sub>W</sub>   | 1.5                 | 57            | -   | 65             | -   | ns    |
|                                            |                  | 3.3                 | 6.4           | -   | 7.3            | -   | ns    |
|                                            |                  | 5                   | 4.6           | -   | 5.2            | -   | ns    |
| CP Frequency                               | f <sub>MAX</sub> | 1.5                 | 9             | -   | 8              | -   | MHz   |
|                                            |                  | 3.3                 | 77            | -   | 68             | -   | MHz   |
|                                            |                  | 5                   | 108           | -   | 95             | -   | MHz   |
| ACT TYPES                                  |                  |                     |               |     |                |     |       |
| Data to CP Set-Up Time                     | t <sub>SU</sub>  | 5<br>(Note 10)      | 2             | -   | 2              | -   | ns    |
| Hold Time                                  | t <sub>H</sub>   | 5                   | 2.2           | -   | 2.5            | -   | ns    |
| Removal Time, $\overline{\text{MR}}$ to CP | t <sub>REM</sub> | 5                   | 1.5           | -   | 1.5            | -   | ns    |
| $\overline{\text{MR}}$ Pulse Width         | t <sub>W</sub>   | 5                   | 3.5           | -   | 4              | -   | ns    |
| Clock Pulse Width                          | t <sub>W</sub>   | 5                   | 5.4           | -   | 6.2            | -   | ns    |
| CP Frequency                               | f <sub>MAX</sub> | 5                   | 91            | -   | 80             | -   | MHz   |

## Switching Specifications Input t<sub>r</sub>, t<sub>f</sub> = 3ns, C<sub>L</sub> = 50pF (Worst Case)

| PARAMETER                   | SYMBOL                              | V <sub>CC</sub> (V) | -40°C TO 85°C |     |      | -55°C TO 125°C |     |      | UNITS |
|-----------------------------|-------------------------------------|---------------------|---------------|-----|------|----------------|-----|------|-------|
|                             |                                     |                     | MIN           | TYP | MAX  | MIN            | TYP | MAX  |       |
| AC TYPES                    |                                     |                     |               |     |      |                |     |      |       |
| Propagation Delay, CP to Qn | t <sub>PLH</sub> , t <sub>PHL</sub> | 1.5                 | -             | -   | 154  | -              | -   | 169  | ns    |
|                             |                                     | 3.3<br>(Note 9)     | 4.9           | -   | 17.2 | 4.7            | -   | 18.9 | ns    |
|                             |                                     | 5<br>(Note 10)      | 3.5           | -   | 12.3 | 3.4            | -   | 13.5 | ns    |

# CD74AC174, CD54/74ACT174

## Switching Specifications Input $t_r, t_f = 3\text{ns}$ , $C_L = 50\text{pF}$ (Worst Case) (Continued)

| PARAMETER                                   | SYMBOL                | $V_{CC}$ (V)   | -40°C TO 85°C |     |      | -55°C TO 125°C |     |      | UNITS |
|---------------------------------------------|-----------------------|----------------|---------------|-----|------|----------------|-----|------|-------|
|                                             |                       |                | MIN           | TYP | MAX  | MIN            | TYP | MAX  |       |
| Propagation Delay, $\overline{MR}$ to $Q_n$ | $t_{PLH}, t_{PHL}$    | 1.5            | -             | -   | 165  | -              | -   | 181  | ns    |
|                                             |                       | 3.3            | 5.2           | -   | 18.5 | 5.1            | -   | 20.3 | ns    |
|                                             |                       | 5              | 3.7           | -   | 13.2 | 3.6            | -   | 14.5 | ns    |
| Input Capacitance                           | $C_I$                 | -              | -             | -   | 10   | -              | -   | 10   | pF    |
| Power Dissipation Capacitance               | $C_{PD}$<br>(Note 11) | -              | -             | 37  | -    | -              | 37  | -    | pF    |
| <b>ACT TYPES</b>                            |                       |                |               |     |      |                |     |      |       |
| Propagation Delay, CP to $Q_n$              | $t_{PLH}, t_{PHL}$    | 5<br>(Note 10) | 3.6           | -   | 12.6 | 3.5            | -   | 14   | ns    |
| Propagation Delay, $\overline{MR}$ to $Q_n$ | $t_{PLH}, t_{PHL}$    | 5              | 4             | -   | 14.1 | 3.9            | -   | 15.5 | ns    |
| Input Capacitance                           | $C_I$                 | -              | -             | -   | 10   | -              | -   | 10   | pF    |
| Power Dissipation Capacitance               | $C_{PD}$<br>(Note 11) | -              | -             | 37  | -    | -              | 37  | -    | pF    |

### NOTES:

- Limits tested 100%.
- 3.3V Min is at 3.6V, Max is at 3V.
- 5V Min is at 5.5V, Max is at 4.5V.
- $C_{PD}$  is used to determine the dynamic power consumption per flip-flop.  
 $P_D = C_{PD} V_{CC}^2 f_i + \Sigma (C_L + V_{CC}^2 f_o) + V_{CC} \Delta I_{CC}$  where  $f_i$  = input frequency,  $f_o$  = output frequency,  $C_L$  = output load capacitance,  $V_{CC}$  = supply voltage.

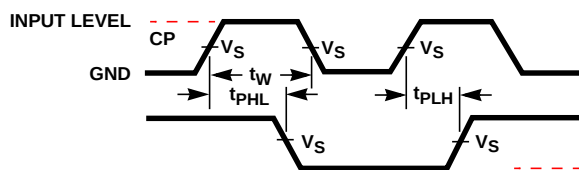


FIGURE 1. PROPAGATION DELAYS

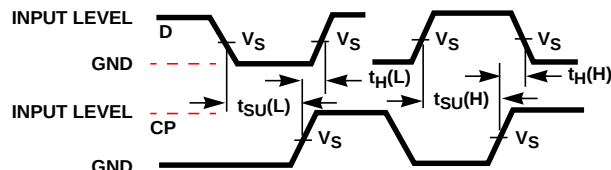


FIGURE 3.

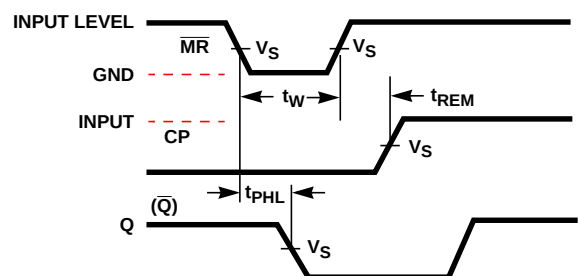
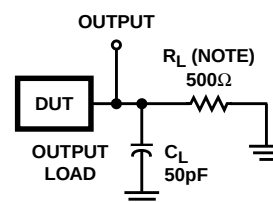


FIGURE 2. RESET OR SET PREREQUISITE AND PROPAGATION DELAYS



NOTE: For AC Series Only: When  $V_{CC} = 1.5\text{V}$ ,  $R_L = 1\text{k}\Omega$ .

|                                 | AC           | ACT          |
|---------------------------------|--------------|--------------|
| Input Level                     | $V_{CC}$     | 3V           |
| Input Switching Voltage, $V_S$  | $0.5 V_{CC}$ | 1.5V         |
| Output Switching Voltage, $V_S$ | $0.5 V_{CC}$ | $0.5 V_{CC}$ |

FIGURE 4. PROPAGATION DELAY TIMES

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