

High-Speed CMOS Logic Octal D-Type Flip-Flop, 3-State Positive-Edge Triggered

February 1998 - Revised May 2003

Features

- Buffered Inputs
- Common Three-State Output Enable Control
- Three-State Outputs
- Bus Line Driving Capability
- Typical Propagation Delay (Clock to Q) = 15ns at $V_{CC} = 5V$, $C_L = 15pF$, $T_A = 25^\circ C$
- Fanout (Over Temperature Range)
 - Standard Outputs 10 LSTTL Loads
 - Bus Driver Outputs 15 LSTTL Loads
- Wide Operating Temperature Range . . . $-55^\circ C$ to $125^\circ C$
- 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 'HC374, 'HCT374, 'HC574, and 'HCT574 are octal D-type flip-flops with 3-state outputs and the capability to drive 15 LSTTL loads. The eight edge-triggered flip-flops enter data into their registers on the LOW to HIGH transition of clock (CP). The output enable (OE) controls the 3-state outputs and is independent of the register operation. When OE is HIGH, the outputs are in the high-impedance state. The 374 and 574 are identical in function and differ only in their pinout arrangements.

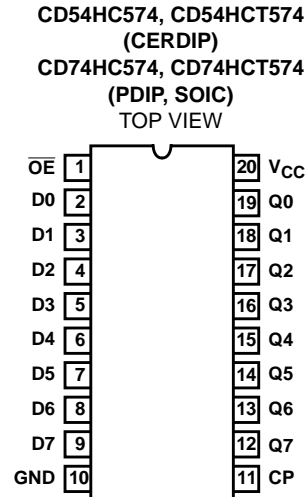
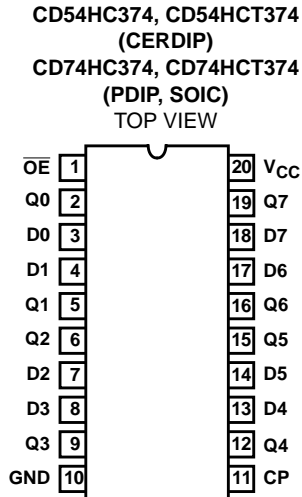
Ordering Information

| PART NUMBER | TEMP. RANGE (°C) | PACKAGE |
|---------------|---------------------|--------------|
| CD54HC374F3A | -55 to 125 | 20 Ld CERDIP |
| CD54HC574F3A | -55 to 125 | 20 Ld CERDIP |
| CD54HCT374F3A | -55 to 125 | 20 Ld CERDIP |
| CD54HCT574F3A | -55 to 125 | 20 Ld CERDIP |
| CD74HC374E | -55 to 125 | 20 Ld PDIP |
| CD74HC374M | -55 to 125 | 20 Ld SOIC |
| CD74HC374M96 | -55 to 125 | 20 Ld SOIC |
| CD74HC574E | -55 to 125 | 20 Ld PDIP |
| CD74HC574M | -55 to 125 | 20 Ld SOIC |
| CD74HC574M96 | -55 to 125 | 20 Ld SOIC |
| CD74HCT374E | -55 to 125 | 20 Ld PDIP |
| CD74HCT374M | -55 to 125 | 20 Ld SOIC |
| CD74HCT374M96 | -55 to 125 | 20 Ld SOIC |
| CD74HCT574E | -55 to 125 | 20 Ld PDIP |
| CD74HCT574M | -55 to 125 | 20 Ld SOIC |
| CD74HCT574M96 | -55 to 125 | 20 Ld SOIC |

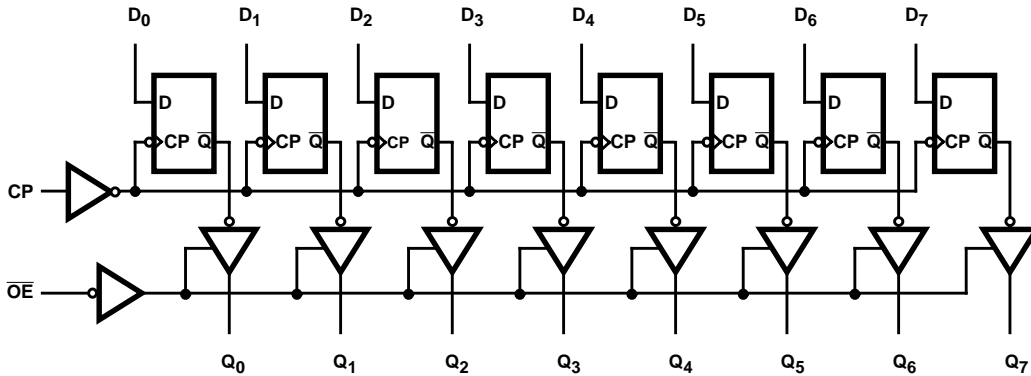
NOTE: When ordering, use the entire part number. The suffix 96 denotes tape and reel.

CD54/74HC374, CD54/74HCT374, CD54/74HC574, CD54/74HCT574

Pinouts



Functional Diagram



TRUTH TABLE

| INPUTS | | | OUTPUT |
|--------|----|----|--------|
| OE | CP | Dn | Qn |
| L | ↑ | H | H |
| L | ↑ | L | L |
| L | L | X | Q0 |
| H | X | X | Z |

H = High Level (Steady State)

L = Low Level (Steady State)

X = Don't Care

↑ = Transition from Low to High Level

Q0 = The level of Q before the indicated steady-state input conditions were established

Z = High Impedance State

CD54/74HC374, CD54/74HCT374, CD54/74HC574, CD54/74HCT574

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 Drain Current, per Output, I_O | |
| For $-0.5V < V_O < V_{CC} + 0.5V$ | $\pm 35mA$ |
| 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} | $\pm 50mA$ |

Thermal Information

| | |
|--|--|
| Thermal Resistance (Typical, Note 1) | θ_{JA} ($^{\circ}C/W$) |
| E (PDIP) Package | 69 |
| M (SOIC) Package | 58 |
| 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 | -0.02 | 2 | 1.9 | - | - | 1.9 | - | 1.9 | - | V |
| | | | -0.02 | -0.02 | 4.5 | 4.4 | - | - | 4.4 | - | 4.4 | - | V |
| | | | -0.02 | -0.02 | 6 | 5.9 | - | - | 5.9 | - | 5.9 | - | V |
| High Level Output Voltage TTL Loads | V_{OH} | V_{IH} or V_{IL} | - | - | - | - | - | - | - | - | - | V | |
| | | | -6 | -6 | 4.5 | 3.98 | - | - | 3.84 | - | 3.7 | - | V |
| | | | -7.8 | -7.8 | 6 | 5.48 | - | - | 5.34 | - | 5.2 | - | V |
| Low Level Output Voltage CMOS Loads | V_{OL} | V_{IH} or V_{IL} | 0.02 | 0.02 | 2 | - | - | 0.1 | - | 0.1 | - | 0.1 | V |
| | | | 0.02 | 0.02 | 4.5 | - | - | 0.1 | - | 0.1 | - | 0.1 | V |
| | | | 0.02 | 0.02 | 6 | - | - | 0.1 | - | 0.1 | - | 0.1 | V |
| Low Level Output Voltage TTL Loads | V_{OL} | V_{IH} or V_{IL} | - | - | - | - | - | - | - | - | - | V | |
| | | | 6 | 6 | 4.5 | - | - | 0.26 | - | 0.33 | - | 0.4 | V |
| | | | 7.8 | 7.8 | 6 | - | - | 0.26 | - | 0.33 | - | 0.4 | V |
| Input Leakage Current | I_I | V_{CC} or GND | - | 6 | - | - | ± 0.1 | - | ± 1 | - | ± 1 | μA | |

CD54/74HC374, CD54/74HCT374, CD54/74HC574, CD54/74HCT574

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 | |
| Quiescent Device Current | I _{CC} | V _{CC} or GND | 0 | 6 | - | - | 8 | - | 80 | - | 160 | μA |
| Three- State Leakage Current | V _{IL} or V _{IH} | V _O =V _{CC} or GND | - | 6 | - | - | ±0.5 | - | ±5.0 | - | ±10 | μA |
| 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 | | | -6 | 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 | | | 6 | 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 |
| Three- State Leakage Current | V _{IL} or V _{IH} | V _O =V _{CC} or GND | - | 6 | - | - | ±0.5 | - | ±5.0 | - | ±10 | 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 | |
|---------|------------|--------|
| | HCT374 | HCT574 |
| D0 - D7 | 0.3 | 0.4 |
| CP | 0.9 | 0.75 |
| OE | 1.3 | 0.6 |

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

CD54/74HC374, CD54/74HCT374, CD54/74HC574, CD54/74HCT574

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 | TYP | MAX | MIN | TYP | MAX | |
| HC TYPES | | | | | | | | | | | | |
| Maximum Clock Frequency | f _{MAX} | 2 | 6 | - | - | 5 | - | - | 4 | - | - | MHz |
| | | 4.5 | 30 | - | - | 25 | - | - | 20 | - | - | MHz |
| | | 6 | 35 | - | - | 29 | - | - | 23 | - | - | MHz |
| Clock Pulse Width | t _W | 2 | 80 | - | - | 100 | - | - | 120 | - | - | ns |
| | | 4.5 | 16 | - | - | 20 | - | - | 24 | - | - | ns |
| | | 6 | 14 | - | - | 17 | - | - | 20 | - | - | ns |
| 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 |
| HCT TYPES | | | | | | | | | | | | |
| Maximum Clock Frequency | f _{MAX} | 4.5 | 30 | - | - | 25 | - | - | 20 | - | - | MHz |
| Clock Pulse Width | t _W | 4.5 | 16 | - | - | 20 | - | - | 24 | - | - | ns |
| Setup Time Data to Clock | t _{SU} | 4.5 | 12 | - | - | 15 | - | - | 18 | - | - | ns |
| Hold Time Data to Clock | t _H | 4.5 | 5 | - | - | 5 | - | - | 5 | - | - | ns |

Switching Specifications C_L = 50pF, 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 Clock to Output | t _{PLH} , t _{PHL} | C _L = 50pF | 2 | - | - | 165 | - | 205 | - | 250 | ns |
| | | | 4.5 | - | - | 33 | - | 41 | - | 50 | ns |
| | | C _L = 15pF | 5 | - | 15 | - | - | - | - | - | ns |
| | | C _L = 50pF | 6 | - | - | 28 | - | 35 | - | 43 | ns |
| Output Disable to Q | t _{PLZ} , t _{PHZ} | 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 |

CD54/74HC374, CD54/74HCT374, CD54/74HC574, CD54/74HCT574

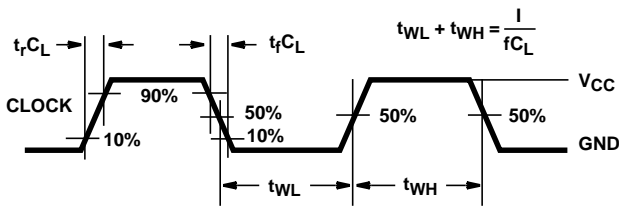
Switching Specifications $C_L = 50\text{pF}$, Input $t_r, t_f = 6\text{ns}$ (Continued)

| 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 | |
| Output Enable to Q | t_{PZL}, t_{PZH} | $C_L = 50\text{pF}$ | 2 | - | - | 150 | - | 190 | - | 225 | ns |
| | | | 4.5 | - | - | 30 | - | 38 | - | 45 | ns |
| | | $C_L = 15\text{pF}$ | 5 | - | 12 | - | - | - | - | - | ns |
| | | $C_L = 50\text{pF}$ | 6 | - | - | 26 | - | 33 | - | 38 | ns |
| Maximum Clock Frequency | f_{MAX} | $C_L = 15\text{pF}$ | 5 | - | 60 | - | - | - | - | - | MHz |
| Output Transition Time | t_{THL}, t_{TLH} | $C_L = 50\text{pF}$ | 2 | - | - | 60 | - | 75 | - | 90 | ns |
| | | | 4.5 | - | - | 12 | - | 15 | - | 18 | ns |
| | | | 6 | - | - | 10 | - | 13 | - | 15 | ns |
| Input Capacitance | C_I | $C_L = 50\text{pF}$ | - | 10 | - | 10 | - | 10 | - | 10 | pF |
| Three-State Output Capacitance | C_O | - | - | 20 | - | 20 | - | 20 | - | 20 | pF |
| Power Dissipation Capacitance (Notes 3, 4) | C_{PD} | $C_L = 15\text{pF}$ | 5 | - | 39 | - | - | - | - | - | pF |
| HCT TYPES | | | | | | | | | | | |
| Propagation Delay Clock to Output | t_{PHL}, t_{PLH} | $C_L = 50\text{pF}$ | 4.5 | - | - | 33 | - | 41 | - | 50 | ns |
| | | $C_L = 15\text{pF}$ | 5 | - | 15 | - | - | - | - | - | ns |
| Output Disable to Q | t_{PZL}, t_{PZH} | $C_L = 50\text{pF}$ | 4.5 | - | - | 28 | - | 35 | - | 42 | ns |
| | | $C_L = 15\text{pF}$ | 5 | - | 11 | - | - | - | - | - | ns |
| Output Enable to Q | t_{PZL}, t_{PZH} | $C_L = 50\text{pF}$ | 4.5 | - | - | 30 | - | 38 | - | 45 | ns |
| | | $C_L = 15\text{pF}$ | 5 | - | 12 | - | - | - | - | - | ns |
| Maximum Clock Frequency | f_{MAX} | $C_L = 15\text{pF}$ | 5 | - | 60 | - | - | - | - | - | MHz |
| Output Transition Time | t_{TLH}, t_{THL} | $C_L = 50\text{pF}$ | 4.5 | - | - | 12 | - | 15 | - | 18 | ns |
| Input Capacitance | C_I | $C_L = 50\text{pF}$ | - | 10 | - | 10 | - | 10 | - | 10 | pF |
| Three-State Output Capacitance | C_O | - | - | 20 | - | 20 | - | 20 | - | 20 | pF |
| Power Dissipation Capacitance (Notes 3, 4) | C_{PD} | $C_L = 15\text{pF}$ | 5 | - | 47 | - | - | - | - | - | pF |

NOTES:

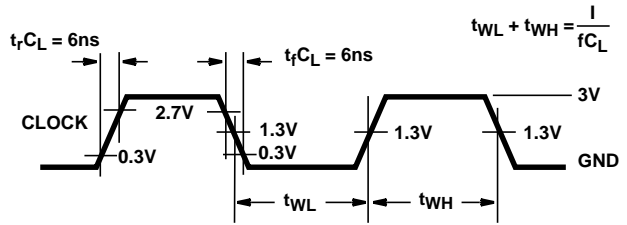
- C_{PD} is used to determine the dynamic power consumption, per package.
- $P_D = C_{PD} V_{CC}^2 f_i + \sum V_{CC}^2 f_O C_L$ where f_i = Input Frequency, f_O = Output Frequency, C_L = Output Load Capacitance, V_{CC} = Supply Voltage.

Test Circuits and Waveforms



NOTE: Outputs should be switching from 10% V_{CC} to 90% V_{CC} in accordance with device truth table. For f_{MAX} , input duty cycle = 50%.

FIGURE 1. HC CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH



NOTE: Outputs should be switching from 10% V_{CC} to 90% V_{CC} in accordance with device truth table. For f_{MAX} , input duty cycle = 50%.

FIGURE 2. HCT CLOCK PULSE RISE AND FALL TIMES AND PULSE WIDTH

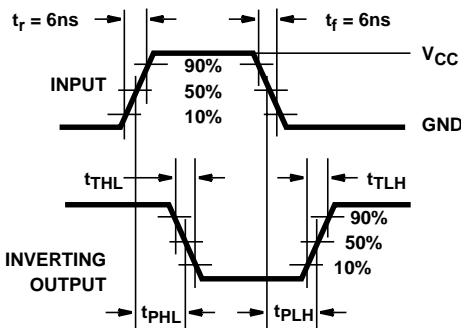


FIGURE 3. HC TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

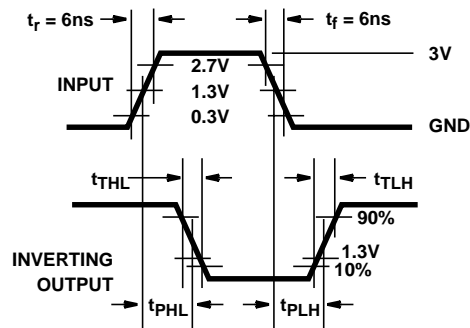


FIGURE 4. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

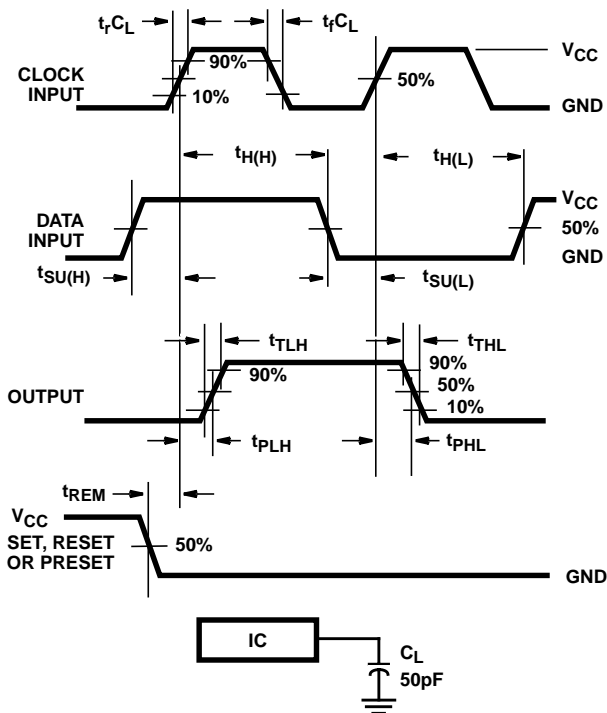


FIGURE 5. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

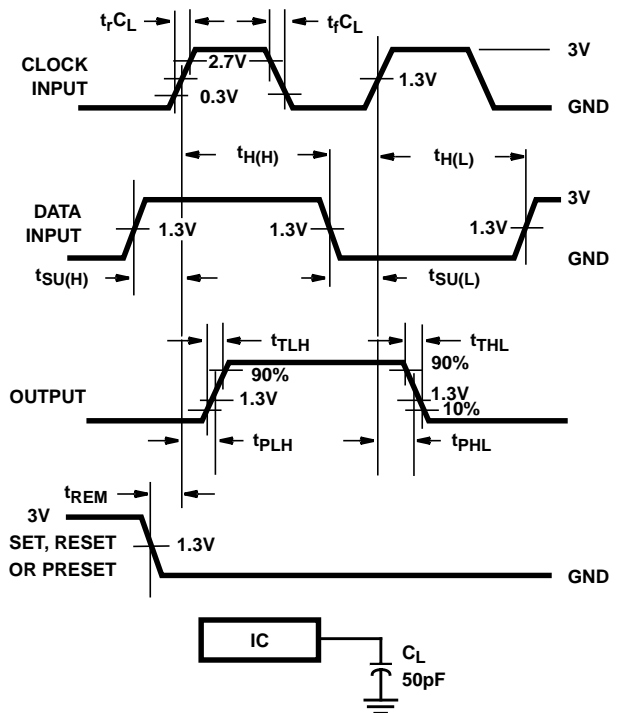


FIGURE 6. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

Test Circuits and Waveforms (Continued)

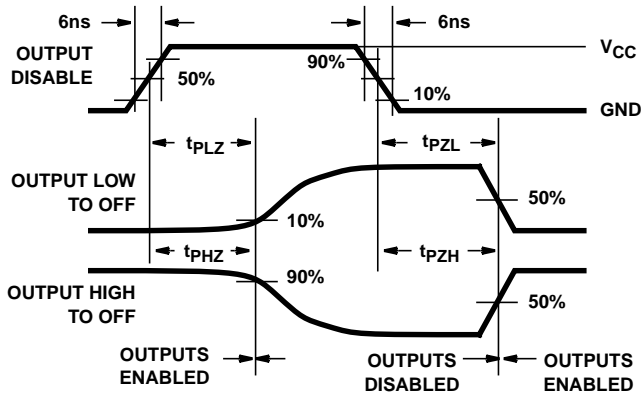


FIGURE 7. HC THREE-STATE PROPAGATION DELAY WAVEFORM

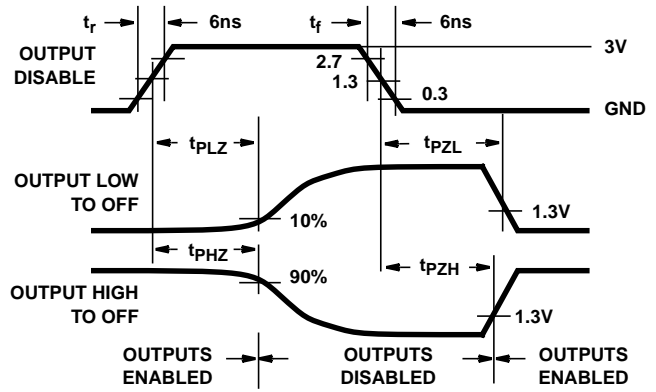
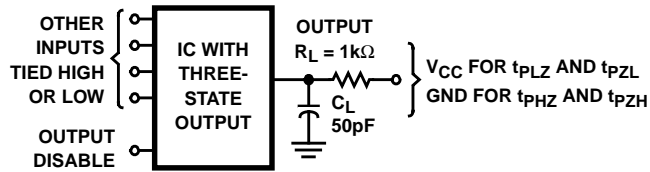


FIGURE 8. HCT THREE-STATE PROPAGATION DELAY WAVEFORM



NOTE: Open drain waveforms t_{PLZ} and t_{PZL} are the same as those for three-state shown on the left. The test circuit is Output $R_L = 1k\Omega$ to V_{CC} , $C_L = 50pF$.

FIGURE 9. HC AND HCT THREE-STATE PROPAGATION DELAY TEST CIRCUIT