

September 1997 - Revised May 2000

## High Speed CMOS Logic Octal D-Type Flip-Flop with Data Enable

### Features

- Buffered Common Clock
- Buffered Inputs
- Typical Propagation Delay = 17ns at  $C_L = 15\text{pF}$ ,  $V_{CC} = 5\text{V}$ ,  $T_A = 25^\circ\text{C}$
- Fanout (Over Temperature Range)
  - Standard Outputs . . . . . 10 LSTTL Loads
  - Bus Driver Outputs . . . . . 15 LSTTL Loads
- Wide Operating Temperature Range . . .  $-55^\circ\text{C}$  to  $125^\circ\text{C}$
- 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  $V_{CC} = 5\text{V}$
- HCT Types
  - 4.5V to 5.5V Operation
  - Direct LSTTL Input Logic Compatibility,  $V_{IL} = 0.8\text{V}$  (Max),  $V_{IH} = 2\text{V}$  (Min)
  - CMOS Input Compatibility,  $I_I \leq 1\mu\text{A}$  at  $V_{OL}$ ,  $V_{OH}$

### Description

The 'HC377 and 'HCT377 are octal D-type flip-flops with a buffered clock (CP) common to all eight flip-flops. All the flip-flops are loaded simultaneously on the positive edge of the clock (CP) when the Data Enable ( $\bar{E}$ ) is Low.

### Ordering Information

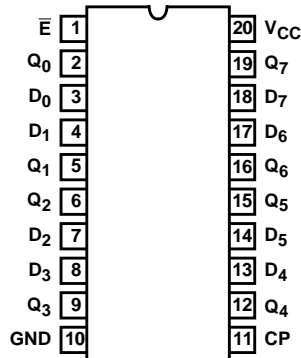
| PART NUMBER   | TEMP. RANGE (°C) | PACKAGE      |
|---------------|------------------|--------------|
| CD54HC377F3A  | -55 to 125       | 20 Ld CERDIP |
| CD74HC377E    | -55 to 125       | 20 Ld PDIP   |
| CD74HC377M    | -55 to 125       | 20 Ld SOIC   |
| CD54HCT377F3A | -55 to 125       | 20 Ld CERDIP |
| CD74HCT377E   | -55 to 125       | 20 Ld PDIP   |
| CD74HCT377M   | -55 to 125       | 20 Ld SOIC   |

#### NOTES:

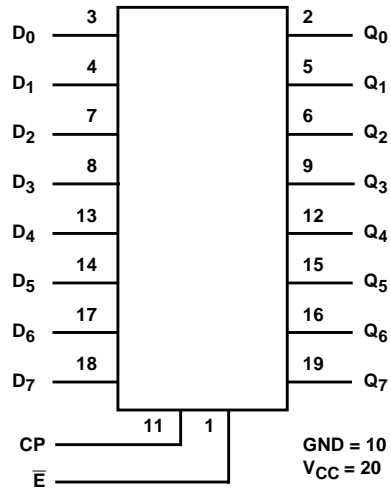
1. When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.
2. Wafer or die for this part number is available which meets all electrical specifications. Please contact your local TI sales office or customer service for ordering information.

### Pinout

CD54HC377, CD54HCT377  
(CERDIP)  
CD74HC377, CD74HCT377  
(PDIP, SOIC)  
TOP VIEW



**Functional Diagram**



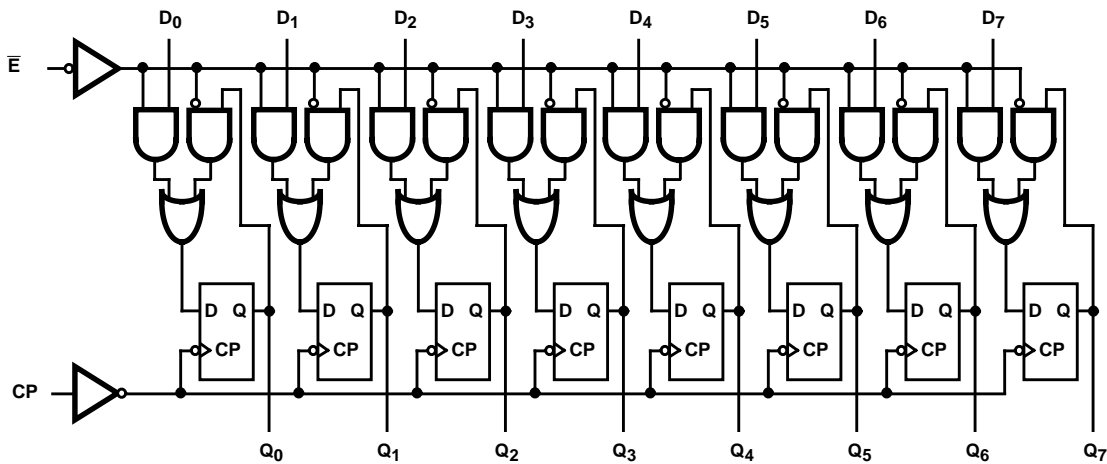
TRUTH TABLE

| OPERATING MODE    | INPUTS |           |       | OUTPUTS   |
|-------------------|--------|-----------|-------|-----------|
|                   | CP     | $\bar{E}$ | $D_n$ | $Q_n$     |
| Load "1"          | ↑      | l         | h     | H         |
| Load "0"          | ↑      | l         | l     | L         |
| Hold (Do Nothing) | ↑      | h         | X     | No Change |
|                   | X      | H         | X     | No Change |

NOTES:

- H = High Voltage Level Steady State.
- h = High Voltage Level One Set-up Time Prior to the Low to High Clock Transition.
- L = Low Voltage Level Steady State.
- l = Low Voltage Level One Set-up Time Prior to the Low to High Clock Transition.
- X = Don't Care.
- ↑ = Low to High Clock Transition.

**Logic Diagram**



## CD54/74HC377, CD54/74HCT377

### 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 3)           | $\theta_{JA}$ ( $^{\circ}C/W$ )           |
| PDIP Package .....                             | 125                                       |
| SOIC Package .....                             | 100                                       |
| Maximum Junction Temperature .....             | $150^{\circ}C$                            |
| Maximum Storage Temperature Range .....        | $-65^{\circ}C$ to $150^{\circ}C$          |
| Maximum Lead Temperature (Soldering 10s) ..... | $300^{\circ}C$<br>(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:

- $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

### DC Electrical Specifications

| 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     |         |
| <b>HC TYPES</b>                         |          |                      |            |              |      |     |           |               |         |                |         |         |
| 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<br>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<br>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<br>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<br>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            | -    | -   | $\pm 0.1$ | -             | $\pm 1$ | -              | $\pm 1$ | $\mu A$ |
| Quiescent Device Current                | $I_{CC}$ | $V_{CC}$ or GND      | 0          | 6            | -    | -   | 8         | -             | 80      | -              | 160     | $\mu A$ |

**CD54/74HC377, CD54/74HCT377**

**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  | TYP | MAX  | MIN           | MAX  | MIN            | MAX |       |
| <b>HCT 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<br>CMOS Loads                        | V <sub>OH</sub>  | V <sub>IH</sub> or V <sub>IL</sub> | -0.02               | 4.5                 | 4.4  | -   | -    | 4.4           | -    | 4.4            | -   | V     |
| High Level Output Voltage<br>TTL Loads                         |                  |                                    | -4                  | 4.5                 | 3.98 | -   | -    | 3.84          | -    | 3.7            | -   | V     |
| Low Level Output Voltage<br>CMOS Loads                         | V <sub>OL</sub>  | V <sub>IH</sub> or V <sub>IL</sub> | 0.02                | 4.5                 | -    | -   | 0.1  | -             | 0.1  | -              | 0.1 | V     |
| Low Level Output Voltage<br>TTL Loads                          |                  |                                    | 4                   | 4.5                 | -    | -   | 0.26 | -             | 0.33 | -              | 0.4 | V     |
| Input Leakage Current  | I <sub>I</sub>   | V <sub>CC</sub> and GND            | 0                   | 5.5                 | -    | -   | ±0.1 | -             | ±1   | -              | ±1  | μA    |
| Quiescent Device Current                                       | I <sub>CC</sub>  | V <sub>CC</sub> or GND             | 0                   | 5.5                 | -    | -   | 8    | -             | 80   | -              | 160 | μA    |
| Additional Quiescent Device Current Per Input Pin: 1 Unit Load | ΔI <sub>CC</sub> | V <sub>CC</sub> -2.1               | -                   | 4.5 to 5.5          | -    | 100 | 360  | -             | 450  | -              | 490 | μA    |

NOTE: For dual-supply systems theoretical worst case (V<sub>I</sub> = 2.4V, V<sub>CC</sub> = 5.5V) specification is 1.8mA.

**HCT Input Loading Table**

| INPUT                     | UNIT LOADS |
|---------------------------|------------|
| $\bar{E}$                 | 1.5        |
| CP                        | 0.5        |
| All D <sub>n</sub> Inputs | 0.25       |

NOTE: Unit Load is ΔI<sub>CC</sub> limit specified in DC Electrical Table, e.g., 360μA max at 25°C.

**Prerequisite for Switching Specifications**

| PARAMETER               | SYMBOL           | TEST CONDITIONS | V <sub>CC</sub> (V) | 25°C |     |     | -40°C TO 85°C |     | -55°C TO 125°C |     | UNITS |
|-------------------------|------------------|-----------------|---------------------|------|-----|-----|---------------|-----|----------------|-----|-------|
|                         |                  |                 |                     | MIN  | TYP | MAX | MIN           | MAX | MIN            | MAX |       |
| <b>HC TYPES</b>         |                  |                 |                     |      |     |     |               |     |                |     |       |
| Maximum Clock Frequency | f <sub>MAX</sub> | -               | 2                   | 6    | -   | -   | 5             | -   | 4              | -   | MHz   |
|                         |                  |                 | 4.5                 | 30   | -   | -   | 25            | -   | 20             | -   | MHz   |
|                         |                  |                 | 6                   | 35   | -   | -   | 29            | -   | 23             | -   | MHz   |
| Clock Pulse Width       | t <sub>W</sub>   | -               | 2                   | 80   | -   | -   | 100           | -   | 120            | -   | ns    |
|                         |                  |                 | 4.5                 | 16   | -   | -   | 20            | -   | 24             | -   | ns    |
|                         |                  |                 | 6                   | 14   | -   | -   | 17            | -   | 20             | -   | ns    |

**CD54/74HC377, CD54/74HCT377**

**Prerequisite for Switching Specifications (Continued)**

| PARAMETER                           | SYMBOL           | TEST CONDITIONS | V <sub>CC</sub> (V) | 25°C |     |     | -40°C TO 85°C |     | -55°C TO 125°C |     | UNITS |
|-------------------------------------|------------------|-----------------|---------------------|------|-----|-----|---------------|-----|----------------|-----|-------|
|                                     |                  |                 |                     | MIN  | TYP | MAX | MIN           | MAX | MIN            | MAX |       |
| Set-up Time, $\bar{E}$ , Data to CP | t <sub>SU</sub>  | -               | 2                   | 60   | -   | -   | 75            | -   | 90             | -   | ns    |
|                                     |                  |                 | 4.5                 | 12   | -   | -   | 15            | -   | 18             | -   | ns    |
|                                     |                  |                 | 6                   | 10   | -   | -   | 13            | -   | 15             | -   | ns    |
| Hold Time, Data to CP               | t <sub>H</sub>   | -               | 2                   | 3    | -   | -   | 3             | -   | 3              | -   | ns    |
|                                     |                  |                 | 4.5                 | 3    | -   | -   | 3             | -   | 3              | -   | ns    |
|                                     |                  |                 | 6                   | 3    | -   | -   | 3             | -   | 3              | -   | ns    |
| Hold Time, $\bar{E}$ to CP          | t <sub>H</sub>   | -               | 2                   | 5    | -   | -   | 5             | -   | 5              | -   | ns    |
|                                     |                  |                 | 4.5                 | 5    | -   | -   | 5             | -   | 5              | -   | ns    |
|                                     |                  |                 | 6                   | 5    | -   | -   | 5             | -   | 5              | -   | ns    |
| <b>HCT TYPES</b>                    |                  |                 |                     |      |     |     |               |     |                |     |       |
| Maximum Clock Frequency             | f <sub>MAX</sub> | -               | 4.5                 | 25   | -   | -   | 20            | -   | 16             | -   | MHz   |
| Clock Pulse Width                   | t <sub>W</sub>   | -               | 4.5                 | 20   | -   | -   | 25            | -   | 30             | -   | ns    |
| Set-up, Time $\bar{E}$ , Data to CP | t <sub>SU</sub>  | -               | 4.5                 | 12   | -   | -   | 15            | -   | 18             | -   | ns    |
| Hold Time, Data to CP               | t <sub>H</sub>   | -               | 4.5                 | 3    | -   | -   | 3             | -   | 3              | -   | ns    |
| Hold Time, $\bar{E}$ to CP          | t <sub>H</sub>   | -               | 4.5                 | 5    | -   | -   | 5             | -   | 5              | -   | ns    |

**Switching Specifications** Input t<sub>r</sub>, t<sub>f</sub> = 6ns

| PARAMETER                                  | SYMBOL                                 | TEST CONDITIONS       | V <sub>CC</sub> (V) | 25°C |     |     | -40°C TO 85°C |     | -55°C TO 125°C |     | UNITS |
|--|--|-----------------------|---------------------|------|-----|-----|---------------|-----|----------------|-----|-------|
|  |  |                       |                     | MIN  | TYP | MAX | MIN           | MAX | MIN            | MAX |       |
| <b>HC TYPES</b>                            |  |                       |                     |      |     |     |               |     |                |     |       |
| Propagation Delay (Figure 1)<br>CP to Q    | t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | C <sub>L</sub> = 50pF | 2                   | -    | -   | 175 | -             | 220 | -              | 265 | ns    |
|  |  |                       | 4.5                 | -    | -   | 35  | -             | 44  | -              | 53  | ns    |
|  |  | C <sub>L</sub> = 15pF | 5                   | -    | 14  | -   | -             | -   | -              | -   | ns    |
|  |  | C <sub>L</sub> = 50pF | 6                   | -    | -   | 30  | -             | 37  | -              | 45  | ns    |
| Output Transition Time (Figure 1)          | t <sub>TLH</sub> , t <sub>THL</sub>    | C <sub>L</sub> = 50pF | 2                   | -    | -   | 75  | -             | 95  | -              | 110 | ns    |
|  |  |                       | 4.5                 | -    | -   | 15  | -             | 19  | -              | 22  | ns    |
|  |  |                       | 6                   | -    | -   | 13  | -             | 16  | -              | 19  | ns    |
| Input Capacitance                          | C <sub>IN</sub>                        | C <sub>L</sub> = 50pF | -                   | -    | -   | 10  | -             | 10  | -              | 10  | pF    |
| Maximum Clock Frequency                    | f <sub>MAX</sub>                       | C <sub>L</sub> = 15pF | 5                   | -    | 60  | -   | -             | -   | -              | -   | MHz   |
| Power Dissipation Capacitance (Notes 4, 5) | C <sub>PD</sub>                        | C <sub>L</sub> = 15pF | 5                   | -    | 31  | -   | -             | -   | -              | -   | pF    |
| <b>HCT TYPES</b>                           |  |                       |                     |      |     |     |               |     |                |     |       |
| Propagation Delay (Figure 1)<br>CP to Q    | t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | C <sub>L</sub> = 50pF | 4.5                 | -    | -   | 38  | -             | 48  | -              | 57  | ns    |
|  |  | C <sub>L</sub> = 15pF | 5                   | -    | 16  | -   | -             | -   | -              | -   | ns    |
| Output Transition Time (Figure 1)          | t <sub>TLH</sub> , t <sub>THL</sub>    | C <sub>L</sub> = 50pF | 4.5                 | -    | -   | 15  | -             | 19  | -              | 22  | ns    |
| Input Capacitance                          | C <sub>IN</sub>                        | C <sub>L</sub> = 50pF | -                   | -    | -   | 10  | -             | 10  | -              | 10  | pF    |

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 |       |
| Maximum Clock Frequency                    | $f_{MAX}$ | $C_L = 15\text{pF}$ | 5            | -    | 50  | -   | -             | -   | -              | -   | MHz   |
| Power Dissipation Capacitance (Notes 4, 5) | $C_{PD}$  | $C_L = 15\text{pF}$ | 5            | -    | 35  | -   | -             | -   | -              | -   | pF    |

NOTES:

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

Test Circuits and Waveforms

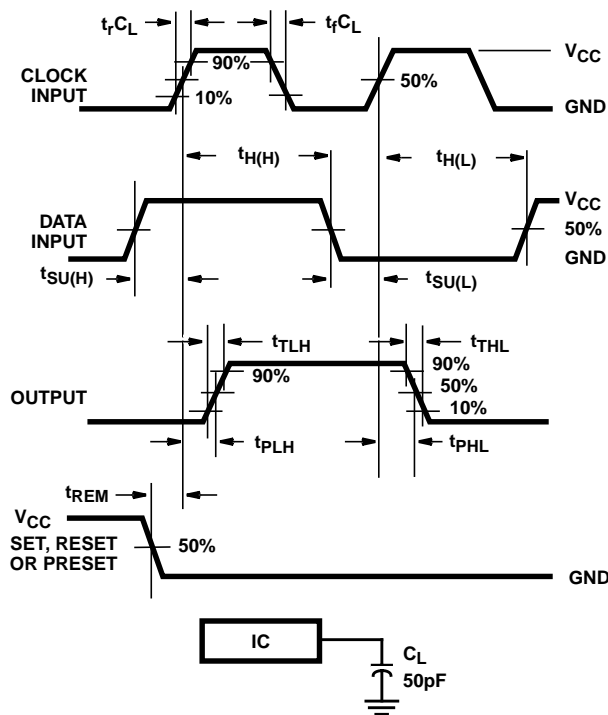


FIGURE 1. HC SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

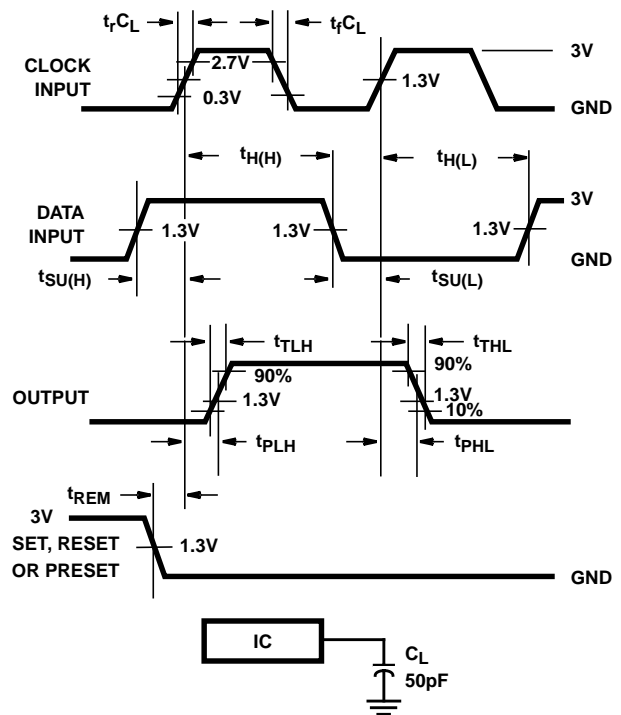


FIGURE 2. HCT SETUP TIMES, HOLD TIMES, REMOVAL TIME, AND PROPAGATION DELAY TIMES FOR EDGE TRIGGERED SEQUENTIAL LOGIC CIRCUITS

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