

# CD74HC251, CD74HCT251

## High Speed CMOS Logic 8-Input Multiplexer; Three-State

November 1997

### Features

- Selects One of Eight Binary Data Inputs
- Three-State Output Capability
- True and Complement Outputs
- Typical (Data to Output) Propagation Delay of 14ns 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
- Alternate Source is Philips
  - 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 Harris CD74HC251 and CD74HCT251 are 8-channel digital multiplexers with three-state outputs, fabricated with high-speed silicon-gate CMOS technology. Together with the low power consumption of standard CMOS integrated circuits, they possess the ability to drive 10 LSTTL loads. The three-state feature makes them ideally suited for interfacing with bus lines in a bus-oriented system.

This multiplexer features both true (Y) and complement ( $\bar{Y}$ ) outputs as well as an output enable (OE) input. The OE must be at a low logic level to enable this device. When the OE input is high, both outputs are in the high-impedance state. When enabled, address information on the data select inputs determines which data input is routed to the Y and  $\bar{Y}$  outputs. The CD74HCT251 logic family is speed, function, and pin-compatible with the standard 74LS251.

### Ordering Information

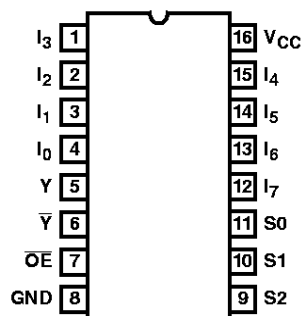
| PART NUMBER | TEMP. RANGE ( $^\circ C$ ) | PACKAGE    | PKG. NO. |
|-------------|----------------------------|------------|----------|
| CD74HC251E  | -55 to 125                 | 16 Ld PDIP | E16.3    |
| CD74HCT251E | -55 to 125                 | 16 Ld PDIP | E16.3    |
| CD74HC251M  | -55 to 125                 | 16 Ld SOIC | M16.15   |
| CD74HCT251M | -55 to 125                 | 16 Ld SOIC | M16.15   |

#### 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 sales office or Harris customer service for ordering information.

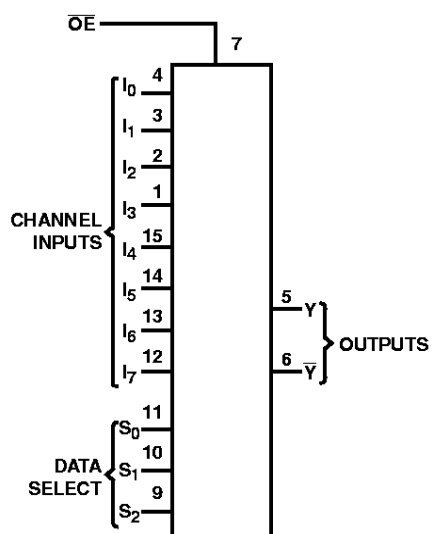
### Pinout

CD74HC251, CD74HCT251  
(PDIP, SOIC)  
TOP VIEW



# CD74HC251, CD74HCT251

## Functional Diagram



TRUTH TABLE

| INPUTS |    |    |                                   | OUTPUT |                  |
|--------|----|----|-----------------------------------|--------|------------------|
| SELECT |    |    | OUTPUT<br>CONTROL $\overline{OE}$ | Y      | $\overline{Y}$   |
| S2     | S1 | S0 |                                   |        |                  |
| X      | X  | X  | H                                 | Z      | Z                |
| L      | L  | L  | L                                 | $I_0$  | $\overline{I_0}$ |
| L      | L  | H  | L                                 | $I_1$  | $\overline{I_1}$ |
| L      | H  | L  | L                                 | $I_2$  | $\overline{I_2}$ |
| L      | H  | H  | L                                 | $I_3$  | $\overline{I_3}$ |
| H      | L  | L  | L                                 | $I_4$  | $\overline{I_4}$ |
| H      | L  | H  | L                                 | $I_5$  | $\overline{I_5}$ |
| H      | H  | L  | L                                 | $I_6$  | $\overline{I_6}$ |
| H      | H  | H  | L                                 | $I_7$  | $\overline{I_7}$ |

NOTE: H = High Voltage Level, L = Low Voltage Level, X = Don't Care, Z = High Impedance (Off),  $I_0, I_1 \dots I_7$  = the level of the respective input.

# CD74HC251, CD74HCT251

## 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  $-0.5V < V_O < V_{CC} + 0.5V$  .....  $\pm 25mA$   
 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 3)  $\theta_{JA}$  ( $^{\circ}C/W$ )  
     PDIP Package ..... 90  
     SOIC Package ..... 160  
 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:

- $\theta_{JA}$  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> (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  |       |
| HC TYPES                                |                 |                                    |                     |                     |      |      |      |               |      |                |      |       |
| High Level Input Voltage                | V <sub>IH</sub> | -                                  | -                   | 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 <sub>IL</sub> | -                                  | -                   | 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 <sub>OH</sub> | V <sub>IH</sub> or V <sub>IL</sub> | -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     |
| -                                       |                 |                                    | -                   | -                   | -    | -    | -    | -             | -    | -              | 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 <sub>OL</sub> | V <sub>IH</sub> or V <sub>IL</sub> | 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     |
| -                                       |                 |                                    | -                   | -                   | -    | -    | -    | -             | -    | -              | V    |       |
| 4                                       |                 |                                    | 4.5                 | -                   | -    | 0.26 | -    | 0.33          | -    | 0.4            | V    |       |
| 5.2                                     |                 |                                    | 6                   | -                   | -    | 0.26 | -    | 0.33          | -    | 0.4            | V    |       |

# CD74HC251, CD74HCT251

## 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 |       |
| Input Leakage Current                                          | I <sub>I</sub>   | V <sub>CC</sub> or GND             | -                                       | 6                   | -    | -   | ±0.1 | -             | ±1   | -              | ±1  | μA    |
| Quiescent Device Current                                       | I <sub>CC</sub>  | V <sub>CC</sub> or GND             | 0                                       | 6                   | -    | -   | 8    | -             | 80   | -              | 160 | μA    |
| Three-State Leakage Current                                    | -                | V <sub>IL</sub> or V <sub>IH</sub> | V <sub>O</sub> = V <sub>CC</sub> or GND | 6                   | -    | -   | ±0.5 | -             | ±5.0 | -              | ±10 | μA    |
| <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    |
| Three-State Leakage Current                                    | -                | V <sub>IL</sub> or V <sub>IH</sub> | V <sub>O</sub> = V <sub>CC</sub> or GND | 6                   | -    | -   | ±0.5 | -             | ±5.0 | -              | ±10 | 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 |
|------------|------------|
| S0, S1, S2 | 0.55       |
| I0 - I7    | 0.5        |
| OE         | 2.65       |

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

# CD74HC251, CD74HCT251

## Switching Specifications Input $t_r, t_f = 6\text{ns}$

| 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 |       |
| HC TYPES                                   |                                     |                       |                                     |                       |     |     |               |     |                |     |       |
| Propagation Delay<br>Select to Outputs     | t <sub>PLH</sub> , t <sub>PHL</sub> | C <sub>L</sub> = 50pF | 2                                   | -                     | -   | 245 | -             | 305 | -              | 370 | ns    |
|                                            |                                     |                       | 4.5                                 | -                     | -   | 49  | -             | 61  | -              | 74  | ns    |
|                                            |                                     | C <sub>L</sub> =15pF  | 5                                   | -                     | 21  | -   | -             | -   | -              | -   | ns    |
|                                            |                                     | C <sub>L</sub> = 50pF | 6                                   | -                     | -   | 42  | -             | 52  | -              | 63  | ns    |
| Data to Outputs                            | t <sub>PLH</sub> , 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                                   | -                     | 12  | -   | -             | -   | -              | -   | ns    |
|                                            |                                     | C <sub>L</sub> = 50pF | 6                                   | -                     | -   | 30  | -             | 37  | -              | 45  | ns    |
| Enable to High Z and Enable from High Z    | t <sub>PLH</sub> , t <sub>PHL</sub> | C <sub>L</sub> = 50pF | 2                                   | -                     | -   | 140 | -             | 175 | -              | 210 | ns    |
|                                            |                                     |                       | 4.5                                 | -                     | -   | 28  | -             | 35  | -              | 42  | ns    |
|                                            |                                     | C <sub>L</sub> =15pF  | 5                                   | -                     | 11  | -   | -             | -   | -              | -   | ns    |
|                                            |                                     | C <sub>L</sub> = 50pF | 6                                   | -                     | -   | 24  | -             | 30  | -              | 36  | ns    |
| Output Transition Time                     | 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>                     | -                     | -                                   | -                     | -   | 10  | -             | 10  | -              | 10  | pF    |
| Three-State Output Capacitance             | C <sub>O</sub>                      | -                     | -                                   | -                     | -   | 15  | -             | 15  | -              | 15  | pF    |
| Power Dissipation Capacitance (Notes 4, 5) | C <sub>PD</sub>                     | -                     | 5                                   | -                     | 60  | -   | -             | -   | -              | -   | pF    |
| HCT TYPES                                  |                                     |                       |                                     |                       |     |     |               |     |                |     |       |
| Propagation Delay<br>Select to Outputs     | t <sub>PLH</sub> , t <sub>PHL</sub> | C <sub>L</sub> = 50pF | 4.5                                 | -                     | -   | 42  | -             | 53  | -              | 63  | ns    |
|                                            |                                     | C <sub>L</sub> =15pF  | 5                                   | -                     | 18  | -   | -             | -   | -              | -   | ns    |
|                                            |                                     | Data to Outputs       | t <sub>PLH</sub> , t <sub>PHL</sub> | C <sub>L</sub> = 50pF | 4.5 | -   | -             | 35  | -              | 44  | -     |
| C <sub>L</sub> =15pF                       | 5                                   |                       |                                     | -                     | 12  | -   | -             | -   | -              | -   | ns    |
| Enable to High Z and Enable from High Z    | t <sub>PLH</sub> , t <sub>PHL</sub> | C <sub>L</sub> = 50pF | 4.5                                 | -                     |     | 30  | -             | 38  | -              | 45  | ns    |
|                                            |                                     | C <sub>L</sub> =15pF  | 5                                   | -                     | 12  | -   | -             | -   | -              | -   | ns    |
| Output Transition Time                     | 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>                     | -                     | -                                   | -                     | -   | 10  | -             | 10  | -              | 10  | pF    |
| Power Dissipation Capacitance (Notes 4, 5) | C <sub>PD</sub>                     | -                     | 5                                   |                       | 60  | -   | -             | -   | -              | -   | pF    |

### NOTES:

- $C_{PD}$  is used to determine the dynamic power consumption, per package.
- $P_D = V_{CC}^2 f_i (C_{PD} + C_L)$  where  $f_i$  = input frequency,  $C_L$  = output load capacitance,  $V_{CC}$  = supply voltage.

## Test Circuits and Waveforms

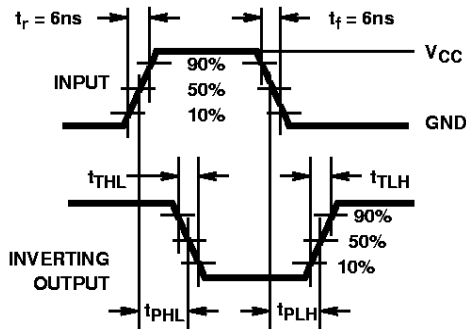


FIGURE 1. HC TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

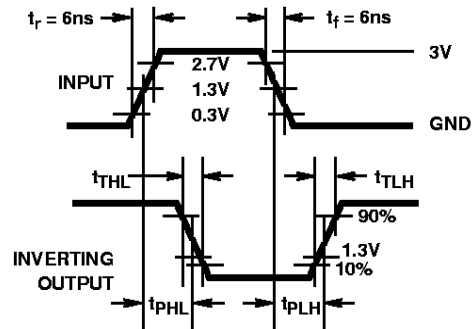


FIGURE 2. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

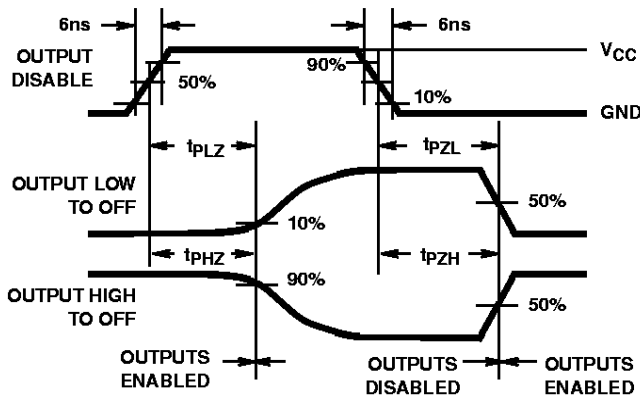


FIGURE 3. HC THREE-STATE PROPAGATION DELAY WAVEFORM

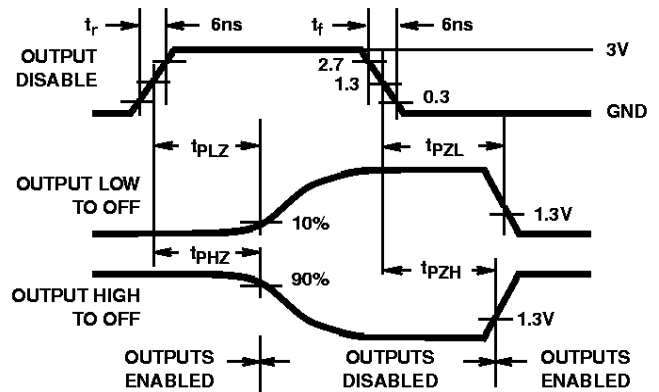
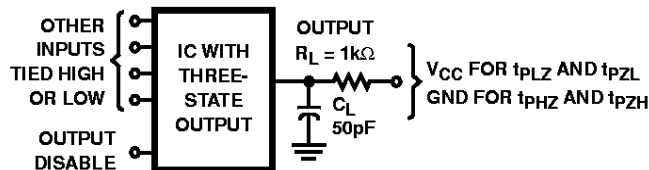


FIGURE 4. HCT THREE-STATE PROPAGATION DELAY WAVEFORM



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 5. HC AND HCT THREE-STATE PROPAGATION DELAY TEST CIRCUIT