

# CD74HC86, CD74HCT86

## High Speed CMOS Logic Quad 2-Input EXCLUSIVE OR Gate

August 1997

### Features

- Typical Propagation Delay: 9ns 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  $V_{OL}$ ,  $V_{OH}$

### Applications

- Logical Comparators
- Parity Generators and Checkers
- Adders and Subtractors

### Description

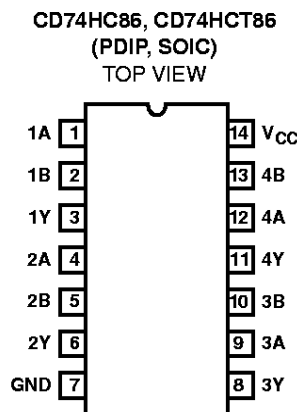
The Harris CD74HC86, CD74HCT86 contain four independent EXCLUSIVE OR gates in one package. They provide the system designer with a means for implementation of the EXCLUSIVE OR function. Logic gates utilize silicon gate CMOS technology to achieve operating speeds similar to LSTTL gates with the low power consumption of standard CMOS integrated circuits. All devices have the ability to drive 10 LSTTL loads. The 74HCT logic family is functionally pin compatible with the standard 74LS logic family.

### Ordering Information

| PART NUMBER | TEMP. RANGE (°C) | PACKAGE    | PKG. NO. |
|-------------|------------------|------------|----------|
| CD74HC86E   | -55 to 125       | 14 Ld PDIP | E14.3    |
| CD74HCT86E  | -55 to 125       | 14 Ld PDIP | E14.3    |
| CD74HC86M   | -55 to 125       | 14 Ld SOIC | M14.15   |
| CD74HCT86M  | -55 to 125       | 14 Ld SOIC | M14.15   |
| CD54HC86W   | -55 to 125       | Wafer      |          |
| CD54HCT86W  | -55 to 125       | Wafer      |          |
| CD54HC86H   | -55 to 125       | Die        |          |

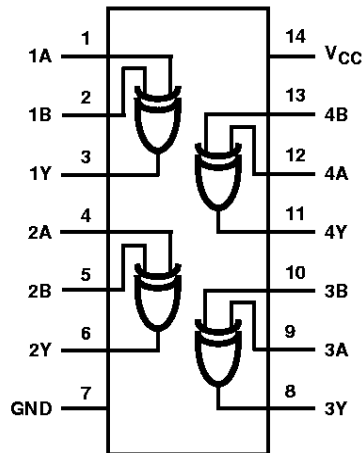
NOTE: When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.

### Pinout



## CD74HC86, CD74HCT86

### Functional Diagram

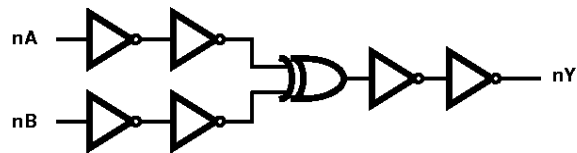


TRUTH TABLE

| INPUTS |    | OUTPUT |
|--------|----|--------|
| nA     | nB | nY     |
| L      | L  | L      |
| L      | H  | H      |
| H      | L  | H      |
| H      | H  | L      |

NOTE: H = High Voltage Level, L = Low Voltage Level

### Logic Symbol



## CD74HC86, CD74HCT86

### 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)           | $\theta_{JA}$ (°C/W) |
| PDIP Package .....                             | 100                  |
| SOIC Package .....                             | 180                  |
| Maximum Junction Temperature .....             | 150°C                |
| Maximum Storage Temperature Range .....        | -65°C to 150°C       |
| Maximum Lead Temperature (Soldering 10s) ..... | 300°C                |
| (SOIC - Lead Tips Only)                        |                      |

### Operating Conditions

|   |                |
|---|----------------|
| Temperature Range ( $T_A$ ) .....               | -55°C to 125°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<br>$V_{IL}$ | -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  |          |                         | -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<br>$V_{IL}$ | 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   |          |                         | 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<br>GND      | -          | 6            | -    | -   | $\pm 0.1$ | -              | $\pm 1$ | -              | $\pm 1$ | $\mu A$ |
| Quiescent Device Current                | $I_{CC}$ | $V_{CC}$ or<br>GND      | 0          | 6            | -    | -   | 2         | -              | 20      | -              | 40      | $\mu A$ |

## CD74HC86, CD74HCT86

### 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                 | -    | -   | 2    | -              | 20   | -              | 40  | μA    |
| Additional Quiescent Device Current Per Input Pin: 1 Unit Load (Note 2) | 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 |
|-------|------------|
| All   | 1          |

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

### 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, Input to Output (Figure 1) | t <sub>PLH</sub> , t <sub>PHL</sub> | C <sub>L</sub> = 50pF | 2                   | -    | -   | 120 | -             | 150 | -              | 180 | ns    |
|   |                                     |                       | 4.5                 | -    | -   | 24  | -             | 30  | -              | 36  | ns    |
|   |                                     |                       | 6                   | -    | -   | 20  | -             | 26  | -              | 31  | ns    |
| Propagation Delay, Data Input to Output Y     | t <sub>PLH</sub> , t <sub>PHL</sub> | C <sub>L</sub> = 15pF | 5                   | -    | 9   | -   | -             | -   | -              | ns  |       |
| Transition Times (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    |

## CD74HC86, CD74HCT86

### 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 |       |
| Input Capacitance                             | $C_I$              | -                   | -            | -    | -   | 10  | -             | 10  | -              | 10  | pF    |
| Power Dissipation Capacitance (Notes 3, 4)    | $C_{PD}$           | -                   | 5            | -    | 22  | -   | -             | -   | -              | -   | pF    |
| <b>HCT TYPES</b>                              |                    |                     |              |      |     |     |               |     |                |     |       |
| Propagation Delay, Input to Output (Figure 2) | $t_{PLH}, t_{PHL}$ | $C_L = 50\text{pF}$ | 4.5          | -    | -   | 32  | -             | 40  | -              | 48  | ns    |
| Propagation Delay, Data Input to Output Y     | $t_{PLH}, t_{PHL}$ | $C_L = 15\text{pF}$ | 5            | -    | 13  | -   | -             | -   | -              | -   | ns    |
| Transition Times (Figure 2)                   | $t_{TLH}, t_{THL}$ | $C_L = 50\text{pF}$ | 4.5          | -    | -   | 15  | -             | 19  | -              | 22  | ns    |
| Input Capacitance                             | $C_I$              | -                   | -            | -    | -   | 10  | -             | 10  | -              | 10  | pF    |
| Power Dissipation Capacitance (Notes 3, 4)    | $C_{PD}$           | -                   | 5            | -    | 27  | -   | -             | -   | -              | -   | pF    |

**NOTES:**

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

### Test Circuits and Waveforms

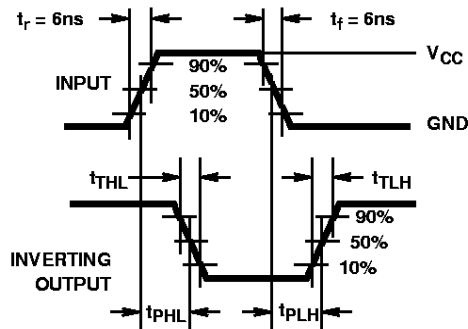


FIGURE 1. HC AND HCU TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

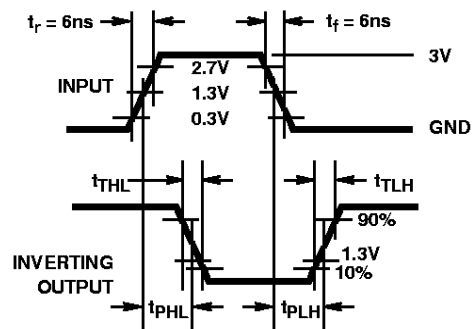


FIGURE 2. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC