

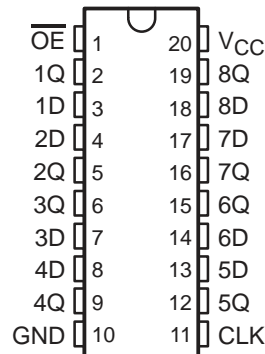
# CD74FCT374

## BiCMOS OCTAL EDGE-TRIGGERED D-TYPE FLIP-FLOP WITH 3-STATE OUTPUTS

SCBS739 – JULY 2000

- BiCMOS Technology With Low Quiescent Power
- 3-State Outputs Drive Bus Lines Directly
- Buffered Inputs
- Noninverted Outputs
- Input/Output Isolation From  $V_{CC}$
- Controlled Output Edge Rates
- 48-mA Output Sink Current
- Output Voltage Swing Limited to 3.7 V
- SCR Latch-Up-Resistant BiCMOS Process and Circuit Design
- Package Options Include Plastic Small-Outline (M) and Shrink Small-Outline (SM) Packages and Standard Plastic (E) DIP

E, M, OR SM PACKAGE  
(TOP VIEW)



### description

The CD74FCT374 is an octal, edge-triggered, D-type flip-flop that uses a small-geometry BiCMOS technology and features 3-state outputs designed specifically for driving highly capacitive or relatively low-impedance loads. This device is particularly suitable for implementing buffer registers, I/O ports, bidirectional bus drivers, and working registers.

The output stage is a combination of bipolar and CMOS transistors that limits the output high level to two diode drops below  $V_{CC}$ . This resultant lowering of output swing (0 V to 3.7 V) reduces power-bus ringing [a source of electromagnetic interference (EMI)] and minimizes  $V_{CC}$  bounce and ground bounce and their effects during simultaneous output switching. The output configuration also enhances switching speed and is capable of sinking 48 mA.

The eight flip-flops enter data into their registers on the low-to-high transition of the clock (CLK). The output-enable ( $\overline{OE}$ ) input controls the 3-state outputs and is independent of the register operation. When  $\overline{OE}$  is high, the outputs are in the high-impedance state.

A buffered  $\overline{OE}$  input can be used to place the eight outputs in either a normal logic state (high or low) or the high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and the increased drive provide the capability to drive bus lines without interface or pullup components.

$\overline{OE}$  does not affect internal operations of the flip-flop. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

To ensure the high-impedance state during power up or power down,  $\overline{OE}$  should be tied to  $V_{CC}$  through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

The CD74FCT374 is characterized for operation from 0°C to 70°C.



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

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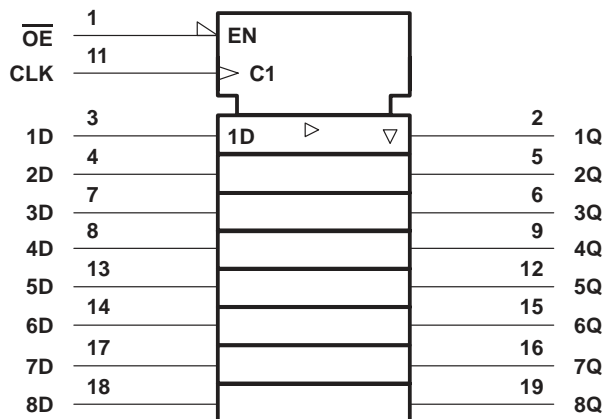
# CD74FCT374 BiCMOS OCTAL EDGE-TRIGGERED D-TYPE FLIP-FLOP WITH 3-STATE OUTPUTS

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FUNCTION TABLE  
(each flip-flop)

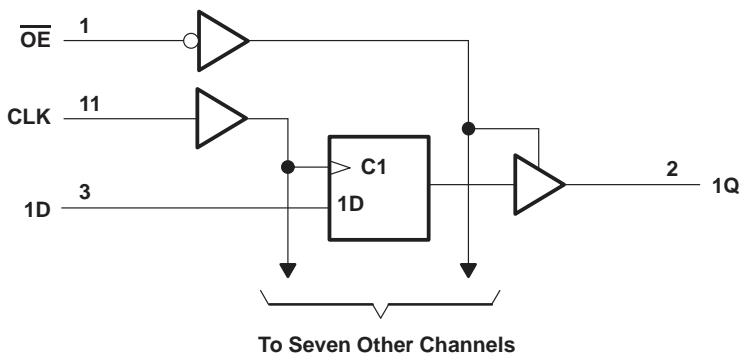
| INPUTS          |        |   | OUTPUT |
|-----------------|--------|---|--------|
| $\overline{OE}$ | CLK    | D | Q      |
| L               | ↑      | H | H      |
| L               | ↑      | L | L      |
| L               | H or L | X | $Q_0$  |
| H               | X      | X | Z      |

## logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

## logic diagram (positive logic)



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## BiCMOS OCTAL EDGE-TRIGGERED D-TYPE FLIP-FLOP WITH 3-STATE OUTPUTS

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### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

|  |                |
|--|----------------|
| DC supply voltage range, $V_{CC}$ .....                                | -0.5 V to 6 V  |
| DC input clamp current, $I_{IK}$ ( $V_I < -0.5$ V) .....               | -20 mA         |
| DC output clamp current, $I_{OK}$ ( $V_O < -0.5$ V) .....              | -50 mA         |
| DC output sink current per output pin, $I_{OL}$ .....                  | 70 mA          |
| DC output source current per output pin, $I_{OH}$ .....                | -30 mA         |
| Continuous current through $V_{CC}$ , $I_{CC}$ .....                   | 140 mA         |
| Continuous current through GND .....                                   | 400 mA         |
| Package thermal impedance, $\theta_{JA}$ (see Note 1): E package ..... | 69°C/W         |
| M package .....  | 58°C/W         |
| SM package .....   | 70°C/W         |
| Storage temperature range, $T_{stg}$ .....                             | -65°C to 150°C |

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51.

### recommended operating conditions (see Note 2)

|  | MIN  | MAX      | UNIT |
|--|------|----------|------|
| $V_{CC}$ Supply voltage                                | 4.75 | 5.25     | V    |
| $V_{IH}$ High-level input voltage                      | 2    |          | V    |
| $V_{IL}$ Low-level input voltage                       |      | 0.8      | V    |
| $V_I$ Input voltage                                    | 0    | $V_{CC}$ | V    |
| $V_O$ Output voltage                                   | 0    | $V_{CC}$ | V    |
| $I_{OH}$ High-level output current                     |      | -15      | mA   |
| $I_{OL}$ Low-level output current                      |      | 48       | mA   |
| $\Delta t/\Delta v$ Input transition rise or fall rate | 0    | 10       | ns/V |
| $T_A$ Operating free-air temperature                   | 0    | 70       | °C   |

NOTE 2: All unused inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

### electrical characteristics over recommended operating temperature range (unless otherwise noted)

| PARAMETER          | TEST CONDITIONS  | $V_{CC}$ | $T_A = 25^\circ\text{C}$ |           | MIN | MAX      | UNIT          |
|--------------------|--|----------|--------------------------|-----------|-----|----------|---------------|
|                    |  |          | MIN                      | MAX       |     |          |               |
| $V_{IK}$           | $I_I = -18$ mA   | 4.75 V   |                          | -1.2      |     | -1.2     | V             |
| $V_{OH}$           | $I_{OH} = -15$ mA                                      | 4.75 V   | 2.4                      |           | 2.4 |          | V             |
| $V_{OL}$           | $I_{OL} = 48$ mA                                       | 4.75 V   |                          | 0.55      |     | 0.55     | V             |
| $I_I$              | $V_I = V_{CC}$ or GND                                  | 5.25 V   |                          | $\pm 0.1$ |     | $\pm 1$  | $\mu\text{A}$ |
| $I_{OZ}$           | $V_O = V_{CC}$ or GND                                  | 5.25 V   |                          | $\pm 0.5$ |     | $\pm 10$ | $\mu\text{A}$ |
| $I_{OS}^\ddagger$  | $V_I = V_{CC}$ or GND, $V_O = 0$                       | 5.25 V   |                          | -60       |     | -60      | mA            |
| $I_{CC}$           | $V_I = V_{CC}$ or GND, $I_O = 0$                       | 5.25 V   |                          | 8         |     | 80       | $\mu\text{A}$ |
| $\Delta I_{CC}^\S$ | One input at 3.4 V,<br>Other inputs at $V_{CC}$ or GND | 5.25 V   |                          | 1.6       |     | 1.6      | mA            |
| $C_i$              | $V_I = V_{CC}$ or GND                                  |          |                          | 10        |     | 10       | pF            |
| $C_o$              | $V_O = V_{CC}$ or GND                                  |          |                          | 15        |     | 15       | pF            |

‡ Not more than one output should be tested at a time, and the duration of the test should not exceed 100 ms.

§ This is the increase in supply current for each input at one of the specified TTL voltage levels rather than 0 V or  $V_{CC}$ .



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**BiCMOS OCTAL EDGE-TRIGGERED D-TYPE FLIP-FLOP**  
**WITH 3-STATE OUTPUTS**

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timing requirements over recommended operating conditions, (unless otherwise noted) (see Figure 1)

|                    |                 |                  | MIN | MAX | UNIT |
|--------------------|-----------------|------------------|-----|-----|------|
| f <sub>clock</sub> | Clock frequency |                  |     | 70  | MHz  |
| t <sub>w</sub>     | Pulse duration  | CLK high or low  | 7   |     | ns   |
| t <sub>su</sub>    | Setup time      | Data before CLK↑ | 2   |     | ns   |
| t <sub>h</sub>     | Hold time       | Data after CLK↑  | 2   |     | ns   |

switching characteristics over recommended operating conditions, V<sub>CC</sub> = 5 V ± 0.25 V (unless otherwise noted) (see Figure 1)

| PARAMETER        | FROM (INPUT)    | TO (OUTPUT) | T <sub>A</sub> = 25°C | MIN | MAX  | UNIT |
|------------------|-----------------|-------------|-----------------------|-----|------|------|
|                  |                 |             | TYP                   |     |      |      |
| f <sub>max</sub> |                 |             |                       | 70  |      | MHz  |
| t <sub>pd</sub>  | CLK             | Q           | 6.6                   | 2   | 10   | ns   |
| t <sub>en</sub>  | $\overline{OE}$ | Q           | 9                     | 1.5 | 12.5 | ns   |
| t <sub>dis</sub> | $\overline{OE}$ | Q           | 6                     | 1.5 | 8    | ns   |

noise characteristics, V<sub>CC</sub> = 5 V, C<sub>L</sub> = 50 pF, T<sub>A</sub> = 25°C

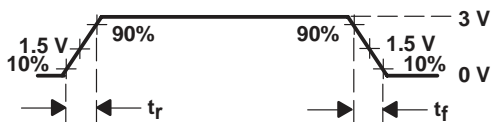
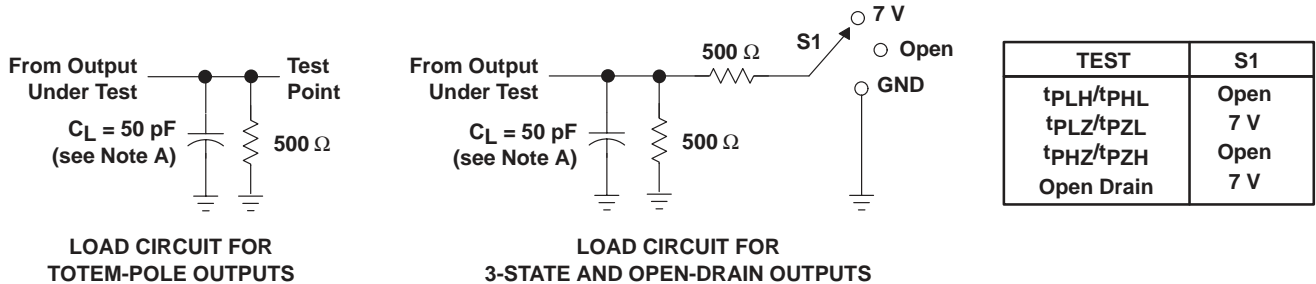
| PARAMETER          |   | MIN | TYP | MAX | UNIT |
|--------------------|---|-----|-----|-----|------|
| V <sub>OL(P)</sub> | Quiet output, maximum dynamic V <sub>OL</sub> |     | 1   |     | V    |
| V <sub>OH(V)</sub> | Quiet output, minimum dynamic V <sub>OH</sub> |     | 0.5 |     | V    |
| V <sub>IH(D)</sub> | High-level dynamic input voltage              | 2   |     |     | V    |
| V <sub>IL(D)</sub> | Low-level dynamic input voltage               |     |     | 0.8 | V    |

operating characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C

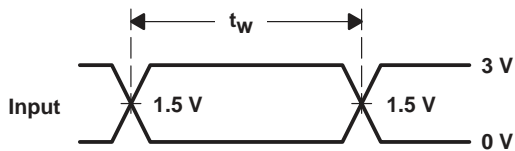
| PARAMETER       |                               | TEST CONDITIONS    | TYP | UNIT |
|-----------------|-------------------------------|--------------------|-----|------|
| C <sub>pd</sub> | Power dissipation capacitance | No load, f = 1 MHz | 33  | pF   |



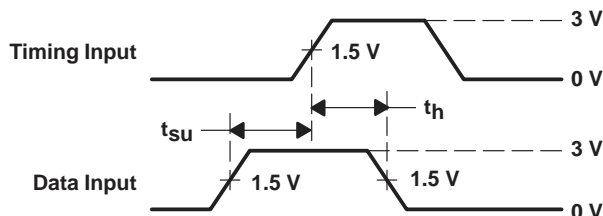
**PARAMETER MEASUREMENT INFORMATION**



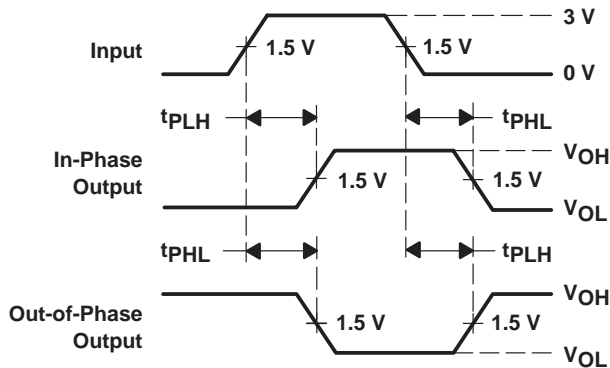
**VOLTAGE WAVEFORM  
INPUT RISE AND FALL TIMES**



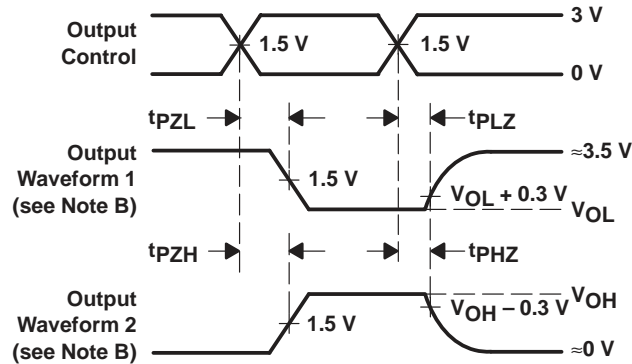
**VOLTAGE WAVEFORMS  
PULSE DURATION**



**VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES  
INVERTING AND NONINVERTING OUTPUTS**



**VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES  
LOW- AND HIGH-LEVEL ENABLING**

- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.  
 C. All input pulses are supplied by generators having the following characteristics: PRR  $\leq$  1 MHz,  $Z_O = 50 \Omega$ ,  $t_r$  and  $t_f = 2.5$  ns.  
 D. The outputs are measured one at a time with one input transition per measurement.  
 E. t<sub>PLZ</sub> and t<sub>PHZ</sub> are the same as t<sub>dis</sub>.  
 F. t<sub>PZL</sub> and t<sub>PZH</sub> are the same as t<sub>en</sub>.  
 G. t<sub>PHL</sub> and t<sub>PLH</sub> are the same as t<sub>pd</sub>.

**Figure 1. Load Circuit and Voltage Waveforms**

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