

# Octal D-Type Flip-Flop with 3-STATE Outputs

## 74VHC574

### General Description

The VHC574 is an advanced high speed CMOS octal flipflop with 3-STATE output fabricated with silicon gate CMOS technology. It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation. This 8-bit D-type flip-flop is controlled by a clock input (CP) and an output enable input ( $\overline{OE}$ ). When the  $\overline{OE}$  input is HIGH, the eight outputs are in a high impedance state.

An input protection circuit ensures that 0 V to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

### Features

- High Speed:  $t_{PD} = 5.6$  ns (Typ) at  $V_{CC} = 5$  V
- High Noise Immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (Min)
- Power Down Protection is Provided on All Inputs
- Low Noise:  $V_{OLP} = 0.6$  V (Typ)
- Low Power Dissipation:  $I_{CC} = 4$   $\mu$ A (Max) @  $T_A = 25^\circ$ C
- Pin and Function Compatible with 74HC574
- These are Pb-Free Devices

### Logic Symbol

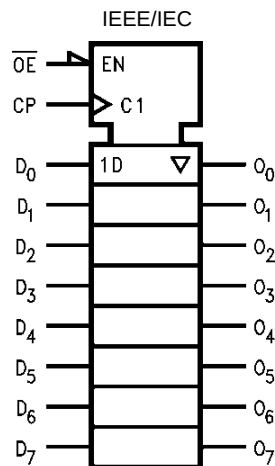
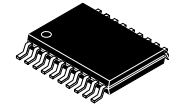
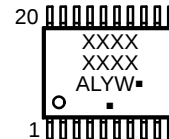


Figure 1. Logic Symbol



TSSOP20, 4.4x6.5  
CASE 948AQ

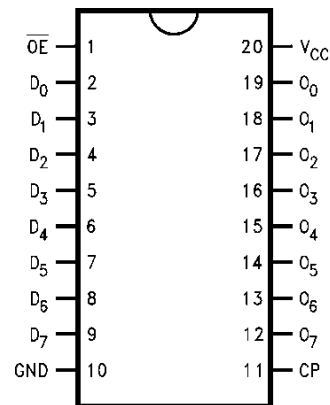
### MARKING DIAGRAM



XXXXXX = Specific Device Code  
 A = Assembly Location  
 L = Wafer Lot  
 Y = Year  
 W = Work Week  
 ■ = Pb-Free Package

(Note: Microdot may be in either location)

### CONNECTION DIAGRAM



### PIN DESCRIPTIONS

| Pin Names                      | Description                 |
|--------------------------------|-----------------------------|
| D <sub>0</sub> -D <sub>7</sub> | Data Inputs                 |
| CP                             | Clock Pulse Input           |
| $\overline{OE}$                | 3-STATE Output Enable Input |
| Q <sub>0</sub> -Q <sub>7</sub> | 3-STATE Outputs             |

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

# 74VHC574

## Functional Description

The VHC574 consists of eight edge-triggered flip-flops with individual D-type inputs and 3-STATE true outputs. The buffered clock and buffered Output Enable are common to all flip-flops. The eight flip-flops will store the state of their individual D inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock (CP) transition. With the Output Enable ( $\overline{OE}$ ) LOW, the contents of the eight flip-flops are available at the outputs. When the  $\overline{OE}$  is HIGH, the outputs go to the high impedance state. Operation of the  $\overline{OE}$  input does not affect the state of the flipflops.

## TRUTH TABLE

| Inputs |            |                 | Outputs |
|--------|------------|-----------------|---------|
| $D_n$  | CP         | $\overline{OE}$ | $O_n$   |
| H      | $\nearrow$ | L               | H       |
| L      | $\nearrow$ | L               | L       |
| X      | X          | H               | Z       |

H = HIGH Voltage Level

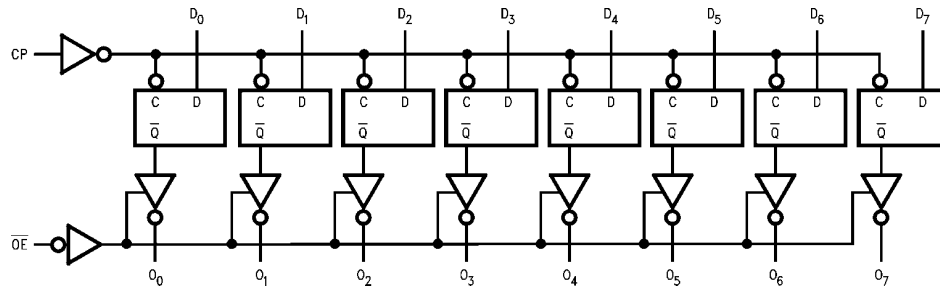
L = LOW Voltage Level

X = Immaterial

Z = High Impedance

$\nearrow$  = LOW-to-HIGH Transition

## Logic Diagram



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Figure 2. Logic Diagram

## MAXIMUM RATINGS

| Symbol        | Parameter                                               |                        | Value                  | Unit                        |
|---------------|---------------------------------------------------------|------------------------|------------------------|-----------------------------|
| $V_{CC}$      | DC Supply Voltage                                       |                        | -0.5 to +6.5           | V                           |
| $V_{IN}$      | DC Input Voltage                                        |                        | -0.5 to +6.5           | V                           |
| $V_{OUT}$     | DC Output Voltage                                       |                        | -0.5 to $V_{CC} + 0.5$ | V                           |
| $I_{IN}$      | DC Input Current, per Pin                               |                        | $\pm 20$               | mA                          |
| $I_{OUT}$     | DC Output Current, per Pin                              |                        | $\pm 25$               | mA                          |
| $I_{CC}$      | DC Supply Current, $V_{CC}$ and GND Pins                |                        | $\pm 75$               | mA                          |
| $I_{IK}$      | Input Clamp Current                                     |                        | -20                    | mA                          |
| $I_{OK}$      | Output Clamp Current                                    |                        | $\pm 20$               | mA                          |
| $T_{STG}$     | Storage Temperature Range                               |                        | -65 to +150            | $^{\circ}\text{C}$          |
| $T_L$         | Lead Temperature, 1 mm from Case for 10 Seconds         |                        | 260                    | $^{\circ}\text{C}$          |
| $T_J$         | Junction Temperature under Bias                         |                        | +150                   | $^{\circ}\text{C}$          |
| $\theta_{JA}$ | Thermal Resistance (Note 2)                             |                        | 150                    | $^{\circ}\text{C}/\text{W}$ |
| $P_D$         | Power Dissipation in Still Air at 25 $^{\circ}\text{C}$ |                        | 833                    | mW                          |
| MSL           | Moisture Sensitivity                                    |                        | Level 1                |                             |
| $F_R$         | Flammability Rating                                     | Oxygen Index: 28 to 34 | UL 94 V-0 @ 0.574 in   |                             |
| $V_{ESD}$     | ESD Withstand Voltage (Note 3)                          | Human Body Model       | 2000                   | V                           |
|               |                                                         | Charged Device Model   | N/A                    |                             |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Applicable to devices with outputs that may be tri-stated.
2. Measured with minimum pad spacing on an FR4 board, using 76 mm-by-114 mm, 2-ounce copper trace no air flow per JESD51-7.
3. HBM tested to EIA / JESD22-A114-A. CDM tested to JESD22-C101-A. JEDEC recommends that ESD qualification to EIA/JESD22-A115A (Machine Model) be discontinued.

## RECOMMENDED OPERATING CONDITIONS

| Symbol                          | Parameter                  |                                  | Min | Max             | Unit |
|---------------------------------|----------------------------|----------------------------------|-----|-----------------|------|
| V <sub>CC</sub>                 | DC Supply Voltage          |                                  | 2.0 | 5.5             | V    |
| V <sub>IN</sub>                 | DC Input Voltage (Note 4)  |                                  | 0   | 5.5             | V    |
| V <sub>OUT</sub>                | DC Output Voltage (Note 4) |                                  | 0   | V <sub>CC</sub> | V    |
| T <sub>A</sub>                  | Operating Temperature      |                                  | −55 | +125            | °C   |
| t <sub>r</sub> , t <sub>f</sub> | Input Rise or Fall Rate    | V <sub>CC</sub> = 3.0 V to 3.6 V | 0   | 100             | ns/V |
|                                 |                            | V <sub>CC</sub> = 4.5 V to 5.5 V | 0   | 20              |      |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

4. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or  $V_{CC}$ ). Unused outputs must be left open.

## DC ELECTRICAL CHARACTERISTICS

| Symbol   | Parameter                        | Conditions                                                 | $V_{CC}$ (V)                      | $T_A = 25^\circ\text{C}$ |      |              | $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ |              | Unit          |
|----------|----------------------------------|------------------------------------------------------------|-----------------------------------|--------------------------|------|--------------|------------------------------------------------|--------------|---------------|
|          |                                  |                                                            |                                   | Min                      | Typ  | Max          | Min                                            | Max          |               |
| $V_{IH}$ | HIGH Level Input Voltage         |                                                            | 2.0                               | 1.50                     | –    | –            | 1.50                                           | –            | V             |
|          |                                  |                                                            | 3.0–5.5                           | $0.7 V_{CC}$             | –    | –            | $0.7 V_{CC}$                                   | –            |               |
| $V_{IL}$ | LOW Level Input Voltage          |                                                            | 2.0                               | –                        | –    | 0.50         | –                                              | 0.50         | V             |
|          |                                  |                                                            | 3.0–5.5                           | –                        | –    | $0.3 V_{CC}$ | –                                              | $0.3 V_{CC}$ |               |
| $V_{OH}$ | HIGH Level Output Voltage        | $V_{IN} = V_{IH}$ or $V_{IL}$                              | $I_{OH} = -50\text{ }\mu\text{A}$ | 2.0                      | 1.9  | 2.0          | –                                              | 1.9          | V             |
|          |                                  |                                                            |                                   | 3.0                      | 2.9  | 3.0          | –                                              | 2.9          |               |
|          |                                  |                                                            |                                   | 4.5                      | 4.4  | 4.5          | –                                              | 4.4          |               |
|          |                                  | $I_{OH} = -4\text{ mA}$                                    | $I_{OH} = -8\text{ mA}$           | 3.0                      | 2.58 | –            | –                                              | 2.48         |               |
|          |                                  |                                                            |                                   | 4.5                      | 3.94 | –            | –                                              | 3.80         |               |
| $V_{OL}$ | LOW Level Output Voltage         | $V_{IN} = V_{IH}$ or $V_{IL}$                              | $I_{OL} = 50\text{ }\mu\text{A}$  | 2.0                      | –    | 0.0          | 0.1                                            | –            | V             |
|          |                                  |                                                            |                                   | 3.0                      | –    | 0.0          | 0.1                                            | –            |               |
|          |                                  |                                                            |                                   | 4.5                      | –    | 0.0          | 0.1                                            | –            |               |
|          |                                  | $I_{OL} = 4\text{ mA}$                                     | $I_{OL} = 8\text{ mA}$            | 3.0                      | –    | –            | 0.36                                           | –            |               |
|          |                                  |                                                            |                                   | 4.5                      | –    | –            | 0.36                                           | –            |               |
| $I_{OZ}$ | 3-STATE Output Off-State Current | $V_{IN} = V_{IH}$ or $V_{IL}$<br>$V_{OUT} = V_{CC}$ or GND | 5.5                               | –                        | –    | $\pm 0.25$   | –                                              | $\pm 2.5$    | $\mu\text{A}$ |
| $I_{IN}$ | Input Leakage Current            | $V_{IN} = 5.5\text{ V}$ or GND                             | 0–5.5                             | –                        | –    | $\pm 0.1$    | –                                              | $\pm 1.0$    | $\mu\text{A}$ |
| $I_{CC}$ | Quiescent Supply Current         | $V_{IN} = V_{CC}$ or GND                                   | 5.5                               | –                        | –    | 4.0          | –                                              | 40.0         | $\mu\text{A}$ |

## NOISE CHARACTERISTICS

| Symbol                | Parameter                                | Conditions           | $V_{CC}$ (V) | $T_A = 25^\circ\text{C}$ |        | Unit |
|-----------------------|------------------------------------------|----------------------|--------------|--------------------------|--------|------|
|                       |                                          |                      |              | Typ                      | Limits |      |
| $V_{OLP}$<br>(Note 5) | Quiet Output Maximum Dynamic $V_{OL}$    | $C_L = 50\text{ pF}$ | 5.0          | 1.0                      | 1.2    | V    |
| $V_{OLV}$<br>(Note 5) | Quiet Output Minimum Dynamic $V_{OL}$    | $C_L = 50\text{ pF}$ | 5.0          | –0.8                     | –1.0   | V    |
| $V_{IHD}$<br>(Note 5) | Minimum HIGH Level Dynamic Input Voltage | $C_L = 50\text{ pF}$ | 5.0          | –                        | 3.5    | V    |
| $V_{ILD}$<br>(Note 5) | Maximum LOW Level Dynamic Input Voltage  | $C_L = 50\text{ pF}$ | 5.0          | –                        | 1.5    | V    |

5. Parameter guaranteed by design.

## AC ELECTRICAL CHARACTERISTICS

| Symbol                                 | Parameter                                      | Conditions              |                        | V <sub>CC</sub> (V) | T <sub>A</sub> = 25°C |      |      | T <sub>A</sub> = -40°C to +85°C |      | Unit |
|----------------------------------------|------------------------------------------------|-------------------------|------------------------|---------------------|-----------------------|------|------|---------------------------------|------|------|
|                                        |                                                |                         |                        |                     | Min                   | Typ  | Max  | Min                             | Max  |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub>   | Propagation Delay Time (CP to O <sub>n</sub> ) |                         | C <sub>L</sub> = 15 pF | 3.3 ±0.3            | –                     | 8.5  | 13.2 | 1.0                             | 15.5 | ns   |
|                                        |                                                |                         | C <sub>L</sub> = 50 pF |                     | –                     | 11.0 | 16.7 | 1.0                             | 19.0 |      |
|                                        |                                                |                         | C <sub>L</sub> = 15 pF | 5.0 ±0.5            | –                     | 5.6  | 8.6  | 1.0                             | 10.0 | ns   |
|                                        |                                                |                         | C <sub>L</sub> = 50 pF |                     | –                     | 7.1  | 10.6 | 1.0                             | 12.0 |      |
| t <sub>PZL</sub><br>t <sub>PZH</sub>   | 3-STATE Output Enable Time                     | R <sub>L</sub> = 1 kΩ   | C <sub>L</sub> = 15 pF | 3.3 ±0.3            | –                     | 8.2  | 12.8 | 1.0                             | 15.0 | ns   |
|                                        |                                                |                         | C <sub>L</sub> = 50 pF |                     | –                     | 10.7 | 16.3 | 1.0                             | 18.5 |      |
|                                        |                                                |                         | C <sub>L</sub> = 15 pF | 5.0 ±0.5            | –                     | 5.9  | 9.0  | 1.0                             | 10.5 | ns   |
|                                        |                                                |                         | C <sub>L</sub> = 50 pF |                     | –                     | 7.4  | 11.0 | 1.0                             | 12.5 |      |
| t <sub>PLZ</sub><br>t <sub>PHZ</sub>   | 3-STATE Output Disable Time                    | R <sub>L</sub> = 1 kΩ   | C <sub>L</sub> = 50 pF | 3.3 ±0.3            | –                     | 11.0 | 15.0 | 1.0                             | 17.0 | ns   |
|                                        |                                                |                         | C <sub>L</sub> = 50 pF | 5.0 ±0.5            | –                     | 7.1  | 10.1 | 1.0                             | 11.5 |      |
| t <sub>OSLH</sub><br>t <sub>OSHL</sub> | Output to Output Skew                          | (Note 6)                | C <sub>L</sub> = 50 pF | 3.3 ±0.3            | –                     | –    | 1.5  | –                               | 1.5  | ns   |
|                                        |                                                |                         | C <sub>L</sub> = 50 pF | 5.0 ±0.5            | –                     | –    | 1.0  | –                               | 1.0  |      |
| f <sub>MAX</sub>                       | Maximum Clock Frequency                        |                         | C <sub>L</sub> = 15 pF | 3.3 ±0.3            | 80                    | 125  | –    | 65                              | –    | MHz  |
|                                        |                                                |                         | C <sub>L</sub> = 50 pF |                     | 50                    | 75   | –    | 45                              | –    |      |
|                                        |                                                |                         | C <sub>L</sub> = 15 pF | 5.0 ±0.5            | 130                   | 180  | –    | 110                             | –    |      |
|                                        |                                                |                         | C <sub>L</sub> = 50 pF |                     | 85                    | 115  | –    | 75                              | –    |      |
| C <sub>IN</sub>                        | Input Capacitance                              | V <sub>CC</sub> = Open  |                        |                     | –                     | 4    | 10   | –                               | 10   | pF   |
| C <sub>OUT</sub>                       | Output Capacitance                             | V <sub>CC</sub> = 5.0 V |                        |                     | –                     | 6    | –    | –                               | –    | pF   |
| C <sub>PD</sub>                        | Power Dissipation Capacitance                  | (Note 7)                |                        |                     | –                     | 28   | –    | –                               | –    | pF   |

6. Parameter guaranteed by design. t<sub>OSLH</sub> = |t<sub>PLH</sub> max – t<sub>PLH</sub> min|; t<sub>OSHL</sub> = |t<sub>PHL</sub> max – t<sub>PHL</sub> min|

7. C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: I<sub>CC</sub> (opr.) = C<sub>PD</sub> × V<sub>CC</sub> × f<sub>IN</sub> + I<sub>CC</sub>/8 (per F/F). The total C<sub>PD</sub> when n pcs. of the Octal D Flip-Flop operates can be calculated by the equation: C<sub>PD</sub> (total) = 20 + 8n.

## AC OPERATING REQUIREMENTS

| Symbol                                 | Parameter                | V <sub>CC</sub> (V) | T <sub>A</sub> = 25°C |     |     | T <sub>A</sub> = -40°C to +85°C |     | Unit |
|----------------------------------------|--------------------------|---------------------|-----------------------|-----|-----|---------------------------------|-----|------|
|                                        |                          |                     | Min                   | Typ | Max | Min                             | Max |      |
| t <sub>W(H)</sub><br>t <sub>W(L)</sub> | Minimum Pulse Width (CP) | 3.3 ±0.3            | 5.0                   | –   | –   | 5.0                             | –   | ns   |
|                                        |                          | 5.0 ±0.5            | 5.0                   | –   | –   | 5.0                             | –   |      |
| t <sub>S</sub>                         | Minimum Set-Up Time      | 3.3 ±0.3            | 3.5                   | –   | –   | 3.5                             | –   | ns   |
|                                        |                          | 5.0 ±0.5            | 3.5                   | –   | –   | 3.5                             | –   |      |
| t <sub>H</sub>                         | Minimum Hold Time        | 3.3 ±0.3            | 1.5                   | –   | –   | 1.5                             | –   | ns   |
|                                        |                          | 5.0 ±0.5            | 1.5                   | –   | –   | 1.5                             | –   |      |

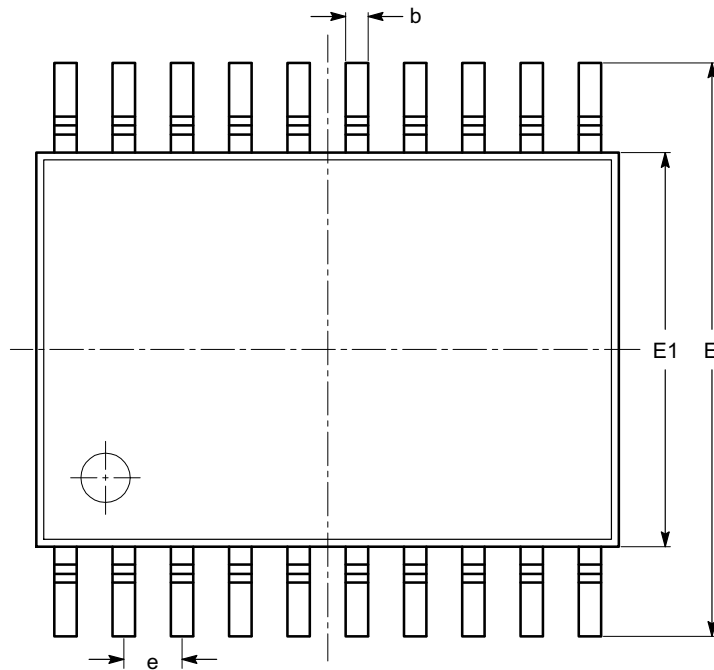
## ORDERING INFORMATION

| Device       | Marking    | Package              | Shipping <sup>†</sup>    |
|--------------|------------|----------------------|--------------------------|
| 74VHC574MTC  | VHC<br>574 | TSSOP20<br>(Pb-Free) | 75 Units / Rail          |
| 74VHC574MTCX | VHC<br>574 | TSSOP20<br>(Pb-Free) | 2500 Units / Tape & Reel |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

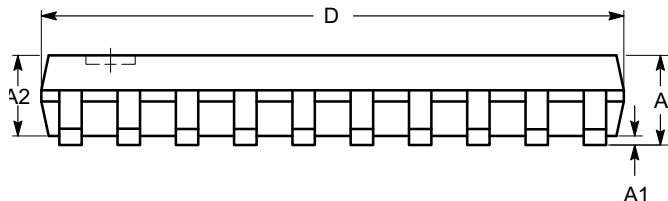
**TSSOP20, 4.4x6.5**  
**CASE 948AQ**  
**ISSUE A**

DATE 19 MAR 2009

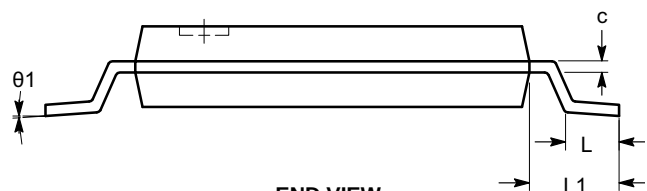


**TOP VIEW**

| SYMBOL | MIN      | NOM  | MAX  |
|--------|----------|------|------|
| A      |          |      | 1.20 |
| A1     | 0.05     |      | 0.15 |
| A2     | 0.80     |      | 1.05 |
| b      | 0.19     |      | 0.30 |
| c      | 0.09     |      | 0.20 |
| D      | 6.40     | 6.50 | 6.60 |
| E      | 6.30     | 6.40 | 6.50 |
| E1     | 4.30     | 4.40 | 4.50 |
| e      | 0.65 BSC |      |      |
| L      | 0.45     | 0.60 | 0.75 |
| L1     | 1.00 REF |      |      |
| θ      | 0°       |      | 8°   |



**SIDE VIEW**



**END VIEW**

**Notes:**

- (1) All dimensions are in millimeters. Angles in degrees.
- (2) Complies with JEDEC MO-153.

|                         |                         |                                                                                                                                                                                     |
|-------------------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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