# MC74VHCT74A

# Dual D-Type Flip-Flop with Set and Reset

The MC74VHCT74A is an advanced high speed CMOS D−type flip−flop fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

The signal level applied to the D input is transferred to Q output during the positive going transition of the Clock pulse.

Reset ($\overline{RD}$) and Set ($\overline{SD}$) are independent of the Clock (CP) and are accomplished by setting the appropriate input Low.

The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output. The inputs tolerate voltages up to 7.0 V, allowing the interface of 5.0 V systems to 3.0 V systems.

The VHCT inputs are compatible with TTL levels. This device can be used as a level converter for interfacing 3.3 V to 5.0 V, because it has full 5.0 V CMOS level output swings.

The VHCT74A input structures provide protection when voltages between 0 V and 5.5 V are applied, regardless of the supply voltage. The output structures also provide protection when $V_{CC}$ = 0 V. These input and output structures help prevent device destruction caused by supply voltage − input/output voltage mismatch, battery backup, hot insertion, etc.

### Features

- High Speed: $f_{max}$ = 60 MHz (Typ) at $V_{CC}$ = 5.0 V
- Low Power Dissipation: $I_{CC}$ = 2 μA (Max) at $T_A$ = 25°C
- Power Down Protection Provided on Inputs
- Balanced Propagation Delays
- Designed for 4.5 V to 5.5 V Operating Range
- Low Noise: $V_{OLP}$ = 0.8 V (Max)
- Pin and Function Compatible with Other Standard Logic Families
- Latchup Performance Exceeds 300 mA
- ESD Performance: HBM > 2000 V; Machine Model > 200 V
- Chip Complexity: 128 FETs or 32 Equivalent Gates
- Pb−Free Packages are Available

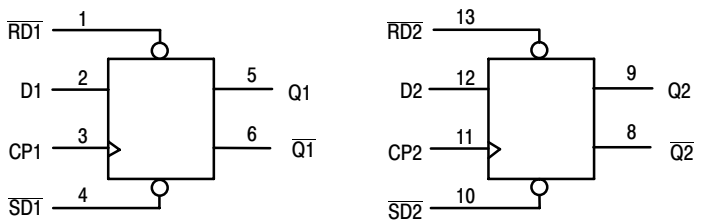
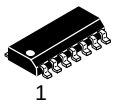



**Figure 2. Logic Diagram**

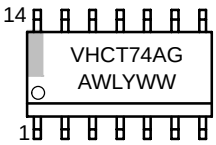
**ON Semiconductor®**

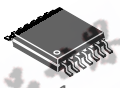
**http://onsemi.com**

### MARKING DIAGRAMS

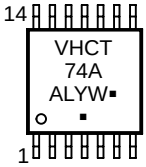


**SOIC−14**
**D SUFFIX**
**CASE 751A**



**TSSOP−14**
**DT SUFFIX**
**CASE 948G**




A = Assembly Location
WL, L = Wafer Lot
Y = Year
WW, W = Work Week
G or ▪ = Pb−Free Package
(Note: Microdot may be in either location)

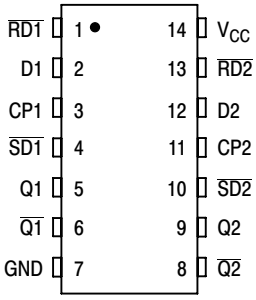



**Figure 1. Pin Assignment**

### FUNCTION TABLE

| Inputs | | | | Outputs | |
|---|---|---|---|---|---|
| $\overline{SD}$ | $\overline{RD}$ | CP | D | Q | $\overline{Q}$ |
| L | H | X | X | H | L |
| H | L | X | X | L | H |
| L | L | X | X | H* | H* |
| H | H | ↑ | H | H | L |
| H | H | ↑ | L | L | H |
| H | H | L | X | No Change | |
| H | H | H | X | No Change | |
| H | H | ↓ | X | No Change | |

*Both outputs will remain high as long as Set and Reset are low, but the output states are unpredictable if Set and Reset go high simultaneously.

### ORDERING INFORMATION

See detailed ordering and shipping information on page 3 of this data sheet.

## MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | DC Supply Voltage | –0.5 to + 7.0 | V |
| $V_{in}$ | DC Input Voltage | –0.5 to + 7.0 | V |
| $V_{out}$ | DC Output Voltage $V_{CC}$ = 0<br>High or Low State | –0.5 to + 7.0<br>–0.5 to $V_{CC}$ + 0.5 | V |
| $I_{IK}$ | Input Diode Current | −20 | mA |
| $I_{OK}$ | Output Diode Current ($V_{OUT}$ < GND; $V_{OUT}$ > $V_{CC}$) | ±20 | mA |
| $I_{out}$ | DC Output Current, per Pin | ±25 | mA |
| $I_{CC}$ | DC Supply Current, $V_{CC}$ and GND Pins | ±50 | mA |
| $P_D$ | Power Dissipation in Still Air, SOIC Packages†<br>TSSOP Package† | 500<br>450 | mW |
| $T_{stg}$ | Storage Temperature | –65 to + 150 | °C |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

†Derating − SOIC Packages: – 7 mW/°C from 65° to 125°C
TSSOP Package: − 6.1 mW/°C from 65° to 125°C

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high−impedance circuit. For proper operation, $V_{in}$ and $V_{out}$ should be constrained to the range GND ≤ ($V_{in}$ or $V_{out}$) ≤ $V_{CC}$.

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.

## RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $V_{CC}$ | DC Supply Voltage | 4.5 | 5.5 | V |
| $V_{in}$ | DC Input Voltage | 0 | 5.5 | V |
| $V_{out}$ | DC Output Voltage $V_{CC}$ = 0<br>High or Low State | 0<br>0 | 5.5<br>$V_{CC}$ | V |
| $T_A$ | Operating Temperature | −40 | + 85 | °C |
| $t_r$, $t_f$ | Input Rise and Fall Time $V_{CC}$ =5.0 V ± 0.5 V | 0 | 20 | ns/V |

## DC ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Test Conditions | $V_{CC}$ V | $T_A$ = 25°C | | | $T_A$ = − 40 to 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | Min | Max | |
| $V_{IH}$ | Minimum High−Level Input Voltage | | 4.5 to 5.5 | 2.0 | | | 2.0 | | V |
| $V_{IL}$ | Maximum Low−Level Input Voltage | | 4.5 to 5.5 | | | 0.8 | | 0.8 | V |
| $V_{OH}$ | Minimum High−Level Output Voltage $V_{in}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = −50 μA | 4.5 | 4.4 | 4.5 | | 4.4 | | V |
| | | $I_{OH}$ = −8 mA | 4.5 | 3.94 | | | 3.80 | | |
| $V_{OL}$ | Maximum Low−Level Output Voltage $V_{in}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 50 μA | 4.5 | | 0.0 | 0.1 | | 0.1 | V |
| | | $I_{OL}$ = 8 mA | 4.5 | | | 0.36 | | 0.44 | |
| $I_{in}$ | Maximum Input Leakage Current | $V_{in}$ = 5.5 V or GND | 0 to 5.5 | | | ±0.1 | | ±1.0 | μA |
| $I_{CC}$ | Maximum Quiescent Supply Current | $V_{in}$ = $V_{CC}$ or GND | 5.5 | | | 2.0 | | 20.0 | μA |
| $I_{CCT}$ | Quiescent Supply Current | Per Input: $V_{IN}$ = 3.4 V<br>Other Input: $V_{CC}$ or GND | 5.5 | | | 1.35 | | 1.50 | mA |
| $I_{OPD}$ | Output Leakage Current | $V_{OUT}$ = 5.5 V | 0 | | | 0.5 | | 5.0 | μA |

**AC ELECTRICAL CHARACTERISTICS** (Input $t_r = t_f = 3.0$ns)

| Symbol | Parameter | Test Conditions | $T_A = 25°C$ Min | $T_A = 25°C$ Typ | $T_A = 25°C$ Max | $T_A = -40$ to $85°C$ Min | $T_A = -40$ to $85°C$ Max | Unit |
|---|---|---|---|---|---|---|---|---|
| $t_{PLH}$, $t_{PHL}$ | Maximum Propagation Delay, CP to Q or $\overline{Q}$ | $V_{CC} = 5.0 \pm 0.5$V $C_L = 15$ pF<br>$C_L = 50$ pF | | 5.8<br>6.3 | 7.8<br>8.8 | 1.0<br>1.0 | 9.0<br>10.0 | ns |
| $t_{PLH}$, $t_{PHL}$ | Maximum Propagation Delay, $\overline{SD}$ or $\overline{RD}$ to Q or $\overline{Q}$ | $V_{CC} = 5.0 \pm 0.5$V $C_L = 15$ pF<br>$C_L = 50$ pF | | 7.6<br>8.1 | 10.4<br>11.4 | 1.0<br>1.0 | 12.0<br>13.0 | ns |
| $f_{max}$ | Maximum Clock Frequency (50% Duty Cycle) | $V_{CC} = 5.0 \pm 0.5$V $C_L = 15$ pF<br>$C_L = 50$ pF | 100<br>80 | 160<br>140 | | 80<br>65 | | MHz |
| $C_{in}$ | Maximum Input Capacitance | | | 4 | 10 | | 10 | pF |

| | | Typical @ 25°C, $V_{CC} = 5.0$ V | |
|---|---|---|---|
| $C_{PD}$ | Power Dissipation Capacitance (Note 1) | 24 | pF |

1. $C_{PD}$ 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: $I_{CC(OPR)} = C_{PD} \bullet V_{CC} \bullet f_{in} + I_{CC}/2$ (per flip−flop). $C_{PD}$ is used to determine the no−load dynamic power consumption; $P_D = C_{PD} \bullet V_{CC}^2 \bullet f_{in} + I_{CC} \bullet V_{CC}$.

**TIMING REQUIREMENTS** (Input $t_r = t_f = 3.0$ ns)

| Symbol | Parameter | $V_{CC}$ V | Guaranteed Limit $T_A = 25°C$ | Guaranteed Limit $T_A = -40$ to $85°C$ | Unit |
|---|---|---|---|---|---|
| $t_w$ | Minimum Pulse Width, CP | 5.0 ± 0.5 | 5.0 | 5.0 | ns |
| $t_w$ | Minimum Pulse Width, $\overline{RD}$ or $\overline{SD}$ | 5.0 ± 0.5 | 5.0 | 5.0 | ns |
| $t_{su}$ | Minimum Setup Time, D to CP | 5.0 ± 0.5 | 5.0 | 5.0 | ns |
| $t_h$ | Minimum Hold Time, D to CP | 5.0 ± 0.5 | 0.0 | 0.0 | ns |
| $t_{rec}$ | Minimum Recovery Time, $\overline{SD}$ or $\overline{RD}$ to CP | 5.0 ± 0.5 | 3.5 | 3.5 | ns |

**ORDERING INFORMATION**

| Device | Package | Shipping† |
|---|---|---|
| MC74VHCT74AD | SOIC−14 | 55 Units / Rail |
| MC74VHCT74ADR2 | SOIC−14 | 2500 / Tape & Reel |
| MC74VHCT74ADR2G | SOIC−14 (Pb−Free) | 2500 / Tape & Reel |
| MC74VHCT74ADT | TSSOP−14* | 96 Units / Rail |
| MC74VHCT74ADTR2 | TSSOP−14* | 2500 / Tape & Reel |
| MC74VHCT74ADTR2G | TSSOP−14* | 2500 / Tape & Reel |

†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.
*This package is inherently Pb−Free.

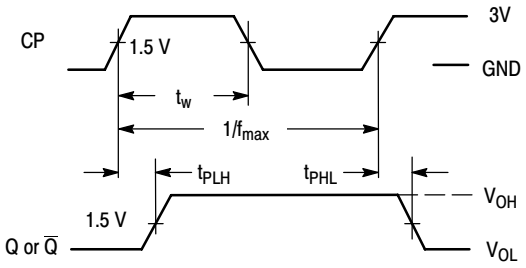



**Figure 3. Switching Waveform**

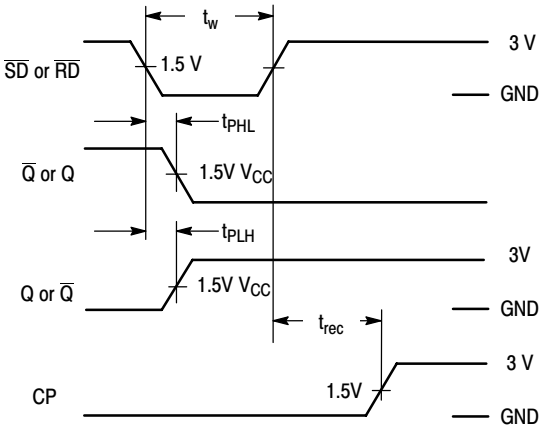



**Figure 4. Switching Waveform**

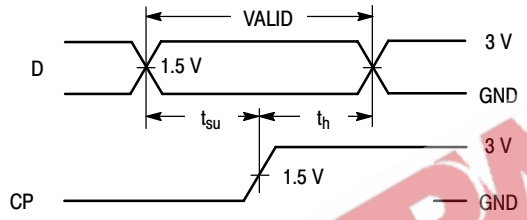
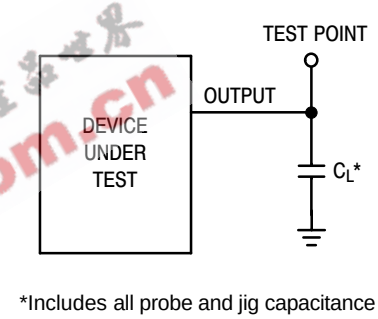



**Figure 5. Switching Waveform**




*Includes all probe and jig capacitance

**Figure 6. Switching Waveform**

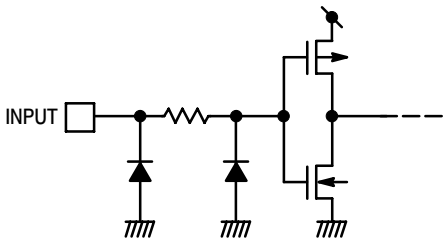
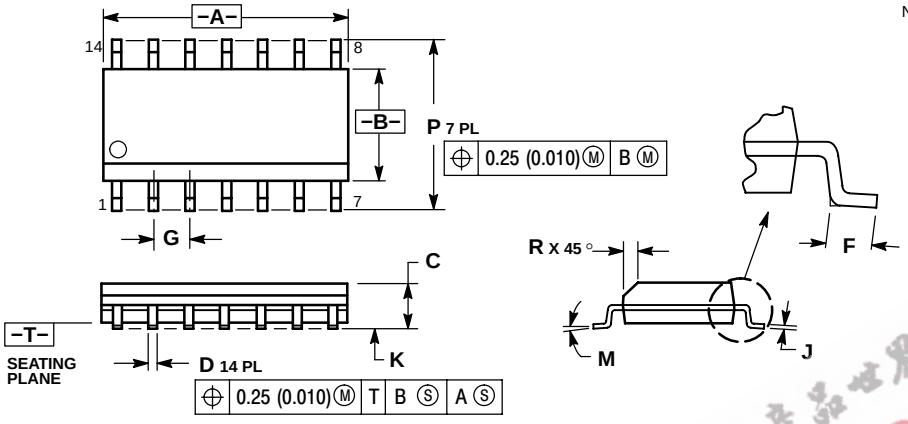



**Figure 7. Input Equivalent Circuit**

## PACKAGE DIMENSIONS

**SOIC−14**
**D SUFFIX**
CASE 751A−03
ISSUE G



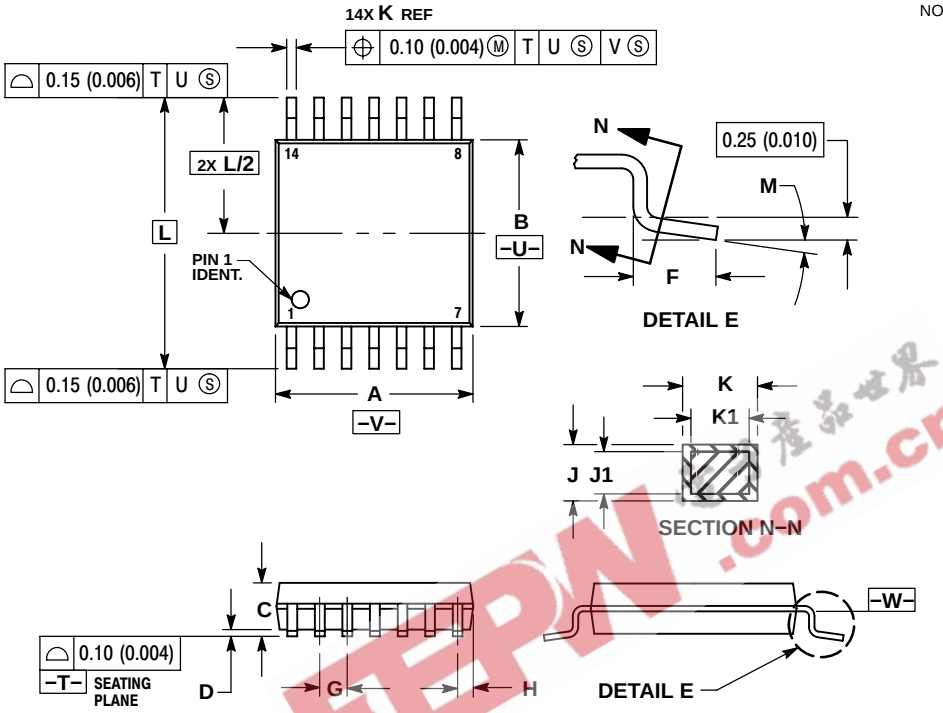

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 8.55 | 8.75 | 0.337 | 0.344 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.054 | 0.068 |
| D | 0.35 | 0.49 | 0.014 | 0.019 |
| F | 0.40 | 1.25 | 0.016 | 0.049 |
| G | 1.27 BSC | | 0.050 BSC | |
| J | 0.19 | 0.25 | 0.008 | 0.009 |
| K | 0.10 | 0.25 | 0.004 | 0.009 |
| M | 0 ° | 7 ° | 0 ° | 7 ° |
| P | 5.80 | 6.20 | 0.228 | 0.244 |
| R | 0.25 | 0.50 | 0.010 | 0.019 |

# MC74VHCT74A

## PACKAGE DIMENSIONS

**TSSOP−14**
**DT SUFFIX**
CASE 948G−01
ISSUE A




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE −W−.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 4.90 | 5.10 | 0.193 | 0.200 |
| B | 4.30 | 4.50 | 0.169 | 0.177 |
| C | −−− | 1.20 | −−− | 0.047 |
| D | 0.05 | 0.15 | 0.002 | 0.006 |
| F | 0.50 | 0.75 | 0.020 | 0.030 |
| G | 0.65 BSC | | 0.026 BSC | |
| H | 0.50 | 0.60 | 0.020 | 0.024 |
| J | 0.09 | 0.20 | 0.004 | 0.008 |
| J1 | 0.09 | 0.16 | 0.004 | 0.006 |
| K | 0.19 | 0.30 | 0.007 | 0.012 |
| K1 | 0.19 | 0.25 | 0.007 | 0.010 |
| L | 6.40 BSC | | 0.252 BSC | |
| M | 0 ° | 8 ° | 0 ° | 8 ° |



### PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT**:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
**Phone**: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
**Fax**: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
**Email**: orderlit@onsemi.com

**N. American Technical Support**: 800−282−9855 Toll Free USA/Canada
**Europe, Middle East and Africa Technical Support:**
Phone: 421 33 790 2910
**Japan Customer Focus Center**
Phone: 81−3−5773−3850

**ON Semiconductor Website**: **www.onsemi.com**

**Order Literature**: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative