

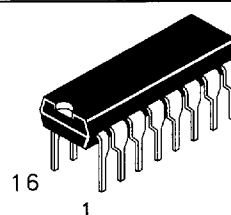
DV74HCT109 Available Q2, 1995

## Dual J-K Flip-Flop with Set and Reset

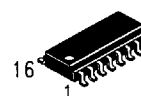
This device consists of two J-K flip-flop with individual set, reset, and clock inputs. Changes at the inputs are reflected at the outputs with the next low-to-high transition of the clock. Both the Q and  $\bar{Q}$  outputs are available from each flip-flop

- Output Drive Capability: 10 LSTTL Loads
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2 to 6 V for HC devices
- Low Input Current: 1  $\mu$ A
- DC, AC parameters guaranteed from -55°C to 125°C

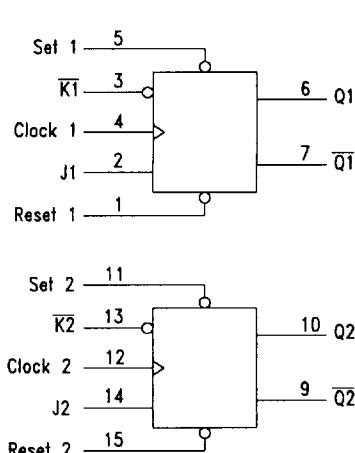
## DV74HC109 DV74HCT109



N Suffix  
Plastic DIP  
AVG-003 Case

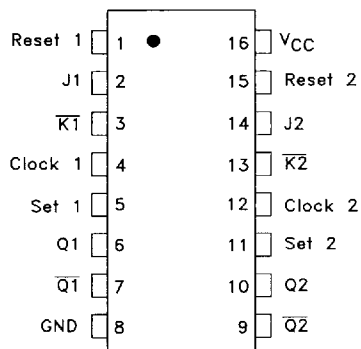


D Suffix  
Plastic SOP  
AVG-004 Case



PIN 16 =  $V_{CC}$   
PIN 8 = GND

### PIN ASSIGNMENT



### TRUTH TABLE

| Inputs |       |       |   |           | Outputs   |           |
|--------|-------|-------|---|-----------|-----------|-----------|
| Set    | Reset | Clock | J | $\bar{K}$ | Q         | $\bar{Q}$ |
| L      | H     | X     | X | X         | H         | L         |
| H      | L     | X     | X | X         | L         | H         |
| L      | L     | X     | X | X         | H*        | H*        |
| H      | H     | ↑     | L | L         | L         | H         |
| H      | H     | ↑     | H | L         | Toggle    |           |
| H      | H     | ↑     | L | H         | No Change |           |
| H      | H     | ↑     | H | H         | H         | L         |
| H      | H     | L     | X | 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  
 ↑ = Low to High Transition  
 ↓ = High to Low Transition  
 X = Don't Care

### ABSOLUTE MAXIMUM RATINGS

Maximum ratings are those values beyond which damage to the device may occur.

| Symbol    | Parameter                                                  | Value                  | Unit |
|-----------|------------------------------------------------------------|------------------------|------|
| $V_{CC}$  | DC Supply Voltage (Referenced to GND)                      | -0.5 to +7.0           | V    |
| $V_{IN}$  | DC Input Voltage (Referenced to GND)                       | -1.5 to $V_{CC} + 1.5$ | V    |
| $V_{OUT}$ | DC Output Voltage (Referenced to GND)                      | -0.5 to $V_{CC} + 0.5$ | V    |
| $I_{IN}$  | DC Input Current, per Pin                                  | ± 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, Plastic DIP<br>SOP Package | 750<br>500             | mW   |
| $T_{STG}$ | Storage Temperature Range                                  | -65 to +150            | °C   |
| TL        | Lead Temperature, 1mm from Case for 10 Seconds             | 260                    | °C   |

# **GUARANTEED OPERATING CONDITIONS**

| Symbol                             | Parameter                                                                                           | Min         | Max                | Unit |
|------------------------------------|-----------------------------------------------------------------------------------------------------|-------------|--------------------|------|
| V <sub>CC</sub>                    | DC Supply Voltage (Referenced to GND)                                                               | 2.0         | 6.0                | V    |
| V <sub>IN</sub> , V <sub>OUT</sub> | DC Input Voltage, Output Voltage (Referenced to GND)                                                | 0           | V <sub>CC</sub>    | V    |
| T <sub>A</sub>                     | Ambient Temperature                                                                                 | -55         | +125               | °C   |
| t <sub>r</sub> , t <sub>f</sub>    | Input Rise and Fall Time<br>V <sub>CC</sub> =2.0V<br>V <sub>CC</sub> =4.0V<br>V <sub>CC</sub> =6.0V | 0<br>0<br>0 | 1000<br>500<br>400 | ns   |

## **HC - 109**

### **DC ELECTRICAL CHARACTERISTICS**

| Symbol          | Parameter                         | Conditions                                                                                                    | V <sub>CC</sub><br>V | Guaranteed Limits   |                    |                    | Unit |
|-----------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------|----------------------|---------------------|--------------------|--------------------|------|
|                 |                                   |                                                                                                               |                      | 25°C<br>to<br>-55°C | ≤85°C              | ≤125°C             |      |
| V <sub>IH</sub> | Minimum High-Level Input Voltage  | V <sub>OUT</sub> = 0.1 V, I <sub>OUT</sub> ≤ 20 μA<br>or V <sub>OUT</sub> = V <sub>CC</sub> - 0.1 V           | 2.0<br>4.5<br>6.0    | 1.5<br>3.15<br>4.2  | 1.5<br>3.15<br>4.2 | 1.5<br>3.15<br>4.2 | V    |
| V <sub>IL</sub> | Maximum Low-Level Input Voltage   | V <sub>OUT</sub> = 0.1 V, I <sub>OUT</sub> ≤ 20 μA<br>or V <sub>OUT</sub> = V <sub>CC</sub> - 0.1 V           | 2.0<br>4.5<br>6.0    | 0.3<br>0.9<br>1.2   | 0.3<br>0.9<br>1.2  | 0.3<br>0.9<br>1.2  | V    |
| V <sub>OH</sub> | Minimum High-Level Output Voltage | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OUT</sub> ≤ 20 μA                              | 2.0<br>4.5<br>6.0    | 1.9<br>4.4<br>5.9   | 1.9<br>4.4<br>5.9  | 1.9<br>4.4<br>5.9  | V    |
|                 |                                   | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , I <sub>OUT</sub> ≤ 4.0 mA<br>I <sub>OUT</sub> ≤ 5.2 mA | 4.5<br>6.0           | 3.98<br>5.48        | 3.84<br>5.34       | 3.7<br>5.2         |      |
| V <sub>OL</sub> | Maximum Low-Level Output Voltage  | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OUT</sub> ≤ 20 μA                              | 2.0<br>4.5<br>6.0    | 0.1<br>0.1<br>0.1   | 0.1<br>0.1<br>0.1  | 0.1<br>0.1<br>0.1  | V    |
|                 |                                   | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , I <sub>OUT</sub> ≤ 4.0 mA<br>I <sub>OUT</sub> ≤ 5.2 mA | 4.5<br>6.0           | 0.26<br>0.26        | 0.33<br>0.33       | 0.40<br>0.40       | V    |
| I <sub>IN</sub> | Maximum Input Leakage Current     | V <sub>IN</sub> = V <sub>CC</sub> or GND                                                                      | 6.0                  | ± 0.1               | ± 1.0              | ± 1.0              | μA   |
| I <sub>CC</sub> | Maximum Quiescent Supply Current  | V <sub>IN</sub> = V <sub>CC</sub> or GND, I <sub>OUT</sub> ≤ 0 μA                                             | 6.0                  | 4.0                 | 40                 | 80                 | μA   |

### **AC ELECTRICAL CHARACTERISTICS** over full operating conditions (C<sub>L</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 6 ns)

| Symbol                                 | Parameter                                                         | V <sub>CC</sub><br>V | Guaranteed Limit    |                 |                 | Unit |
|----------------------------------------|-------------------------------------------------------------------|----------------------|---------------------|-----------------|-----------------|------|
|                                        |                                                                   |                      | 25°C<br>to<br>-55°C | ≤85°C           | ≤125°C          |      |
| f <sub>max</sub>                       | Maximum Clock Frequency (50% Cycle)                               | 2.0<br>4.5<br>6.0    | 6.0<br>30<br>35     | 4.8<br>24<br>28 | 4.0<br>20<br>24 | MHz  |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Maximum Propagation Delay Time,<br>Clock to Q or $\bar{Q}$        | 2.0<br>4.5<br>6.0    | 175<br>35<br>30     | 220<br>44<br>37 | 265<br>53<br>45 | ns   |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Maximum Propagation Delay Time,<br>Set or Reset to Q or $\bar{Q}$ | 2.0<br>4.5<br>6.0    | 230<br>46<br>39     | 290<br>58<br>49 | 345<br>69<br>59 | ns   |
| t <sub>TLH</sub> ,<br>t <sub>THL</sub> | Maximum Output Transition Time<br>Any Output                      | 2.0<br>4.5<br>6.0    | 75<br>15<br>13      | 95<br>19<br>16  | 110<br>22<br>19 | ns   |
| C <sub>IN</sub>                        | Maximum Input Capacitance                                         | —                    | 10                  | 10              | 10              | pF   |

|     |                                                                                                                              |                           |    |
|-----|------------------------------------------------------------------------------------------------------------------------------|---------------------------|----|
| CPD | Power Dissipation Capacitance (Per Gate)<br>Used to determine the no-load dynamic power consumption,<br>PD=CPD VCC²f+ICC VCC | Typical @ 25°C, VCC = 5 V | pF |
|     |                                                                                                                              | 40                        |    |

**TIMING REQUIREMENTS** (Input  $t_r=t_f=6$  ns)

| Symbol           | Parameter                                             | V <sub>CC</sub><br>V | Guaranteed Limit |       |        | Unit |
|------------------|-------------------------------------------------------|----------------------|------------------|-------|--------|------|
|                  |                                                       |                      | 25°C to<br>-55°C | ≤85°C | ≤125°C |      |
| t <sub>su</sub>  | Minimum Setup Time, J or $\bar{K}$ to Clock           | 2.0                  | 100              | 125   | 150    | ns   |
|                  |                                                       | 4.5                  | 20               | 25    | 30     |      |
|                  |                                                       | 6.0                  | 17               | 21    | 26     |      |
| t <sub>h</sub>   | Minimum Hold Time, Clock to J or $\bar{K}$            | 2.0                  | 5                | 5     | 5      | ns   |
|                  |                                                       | 4.5                  | 5                | 5     | 5      |      |
|                  |                                                       | 6.0                  | 5                | 5     | 5      |      |
| t <sub>rec</sub> | Minimum Recovery Time, Set or Reset Inactive to Clock | 2.0                  | 5                | 5     | 5      | ns   |
|                  |                                                       | 4.5                  | 5                | 5     | 5      |      |
|                  |                                                       | 6.0                  | 5                | 5     | 5      |      |
| t <sub>w</sub>   | Minimum Pulse Width, Set or Reset                     | 2.0                  | 80               | 100   | 120    | ns   |
|                  |                                                       | 4.5                  | 16               | 20    | 24     |      |
|                  |                                                       | 6.0                  | 14               | 17    | 20     |      |
| t <sub>w</sub>   | Minimum Pulse Width, Clock                            | 2.0                  | 80               | 100   | 120    | ns   |
|                  |                                                       | 4.5                  | 16               | 20    | 24     |      |
|                  |                                                       | 6.0                  | 14               | 17    | 20     |      |

**HCT- 109****DC ELECTRICAL CHARACTERISTICS**

| Symbol          | Parameter                         | Conditions                                                                          | V <sub>CC</sub><br>V | Guaranteed Limits |              |              |              |              |              | Unit |
|-----------------|-----------------------------------|-------------------------------------------------------------------------------------|----------------------|-------------------|--------------|--------------|--------------|--------------|--------------|------|
|                 |                                   |                                                                                     |                      | 25°C to<br>-55°C  |              | ≤85°C        |              | ≤125°C       |              |      |
|                 |                                   |                                                                                     |                      | Min               | Max          | Min          | Max          | Min          | Max          |      |
| V <sub>IH</sub> | Minimum High-Level Input Voltage  | V <sub>OUT</sub> = 0.1 V or V <sub>CC</sub> -0.1 V<br> I <sub>OUT</sub>   ≤ 20 μA   | 4.5<br>5.5           | 2.00<br>2.00      |              | 2.00<br>2.00 |              | 2.00<br>2.00 |              | V    |
| V <sub>IL</sub> | Maximum Low- Level Input Voltage  | V <sub>OUT</sub> =0.1 V or V <sub>CC</sub> - 0.1 V<br> I <sub>OUT</sub>   ≤ 20 μA   | 4.5<br>5.5           |                   | 0.80<br>0.80 |              | 0.80<br>0.80 |              | 0.80<br>0.80 | V    |
| V <sub>OH</sub> | Minimum High-Level Output Voltage | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br> I <sub>OUT</sub>   ≤ 20 μA | 4.5<br>5.5           | 4.40<br>5.40      |              | 4.40<br>5.40 |              | 4.40<br>5.40 |              | V    |
|                 |                                   | V <sub>IN</sub> =V <sub>IL</sub> or V <sub>IH</sub>  I <sub>OUT</sub>   ≤4.0 mA     | 4.5                  | 3.98              |              | 3.84         |              | 3.70         |              | V    |
| V <sub>OL</sub> | Maximum Low Level Output Voltage  | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   ≤ 20 μA | 4.5<br>5.5           |                   | 0.1<br>0.1   |              | 0.1<br>0.1   |              | 0.1<br>0.1   | V    |
|                 |                                   | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>OUT</sub>   ≤ 4.0mA    | 4.5                  |                   | 0.26         |              | 0.33         |              | 0.40         | V    |
| I <sub>IN</sub> | Maximum Input Leakage Current     | V <sub>IN</sub> = V <sub>CC</sub> or GND                                            | 5.5                  |                   | ± 0.1        |              | ± 1.0        |              | ± 1.0        | μA   |
| I <sub>CC</sub> | Maximum Quiescent Supply Current  | V <sub>IN</sub> = V <sub>CC</sub> or GND<br> I <sub>OUT</sub>   = 0 μA              | 5.5                  |                   | 4.0          |              | 40           |              | 80           | μA   |

| $\Delta I_{CC}$ | Additional Quiescent Supply Current | $V_{IN}=2.4V$ , Any One Input<br>$V_{IN}=V_{CC}$ or GND, Other Inputs<br>$I_{OUT}=0\ \mu A$ | 5.5 | $\geq -55^{\circ}C$ | $25^{\circ}C$ to $125^{\circ}C$ | mA |
|-----------------|-------------------------------------|---------------------------------------------------------------------------------------------|-----|---------------------|---------------------------------|----|
|                 |                                     |                                                                                             |     | 2.9                 | 2.4                             |    |

**AC ELECTRICAL CHARACTERISTICS** over full operating conditions (CL=50pF, Input  $t_r=t_f=6$ ns)

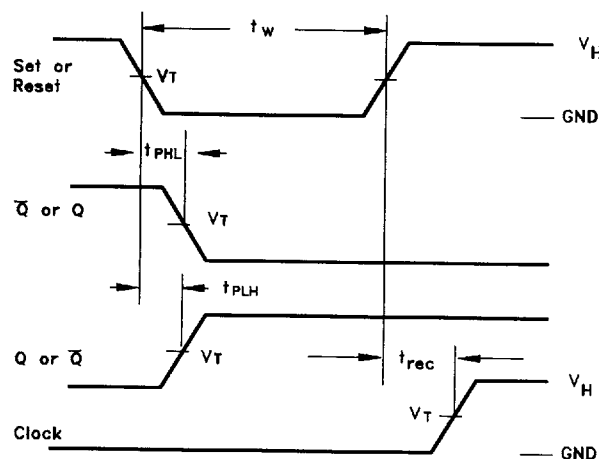
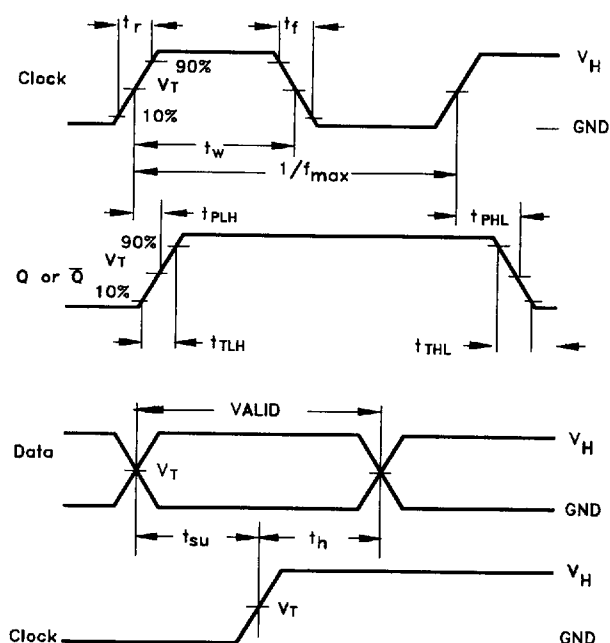
| Symbol                                 | Parameter                                                         | V <sub>CC</sub><br>V | Guaranteed Limit |       |        | Unit |
|----------------------------------------|-------------------------------------------------------------------|----------------------|------------------|-------|--------|------|
|                                        |                                                                   |                      | 25°C to<br>-55°C | ≤85°C | ≤125°C |      |
| f <sub>max</sub>                       | Maximum Clock Frequency (50% Cycle)                               | 5.0                  | 30               | 24    | 20     | MHz  |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Maximum Propagation Delay Time,<br>Clock to Q or $\bar{Q}$        | 5.0                  | 35               | 44    | 53     | ns   |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Maximum Propagation Delay Time,<br>Set or Reset to Q or $\bar{Q}$ | 5.0                  | 46               | 58    | 69     | ns   |
| t <sub>TLH</sub> ,<br>t <sub>THL</sub> | Maximum Output Transition Time<br>Any Output                      | 5.0                  | 15               | 19    | 22     | ns   |
| C <sub>IN</sub>                        | Maximum Input Capacitance                                         | —                    | 10               | 10    | 10     | pF   |

| Symbol          | Parameter                                                                                                                                                                                                     | V <sub>CC</sub><br>V                  | Guaranteed Limit    |       |        | Unit |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------|-------|--------|------|
|                 |                                                                                                                                                                                                               |                                       | 25°C<br>to<br>−55°C | ≤85°C | ≤125°C |      |
| C <sub>IN</sub> | Maximum Input Capacitance                                                                                                                                                                                     | —                                     | 10                  | 10    | 10     | pF   |
| C <sub>PD</sub> | Power Dissipation Capacitance (Per Inverter)<br>Used to determine the no-load dynamic power consumption,<br>P <sub>D</sub> = C <sub>PD</sub> V <sub>CC</sub> <sup>2</sup> f + I <sub>CC</sub> V <sub>CC</sub> | Typical @ 25°C, V <sub>CC</sub> = 5 V |                     |       |        |      |
|                 |                                                                                                                                                                                                               | 15                                    |                     |       |        | pF   |

# TIMING REQUIREMENTS (Input t<sub>r</sub>=t<sub>f</sub>=6 ns)

| Symbol           | Parameter                                             | V <sub>CC</sub> | Guaranteed Limit |       |         | Unit |
|------------------|-------------------------------------------------------|-----------------|------------------|-------|---------|------|
|                  |                                                       |                 | 25°C to<br>-55°C | ≤85°C | ≤125 °C |      |
| t <sub>su</sub>  | Minimum Setup Time, J or $\bar{K}$ to Clock           | 5.0             | 20               | 25    | 30      | ns   |
| t <sub>h</sub>   | Minimum Hold Time, Clock to J or $\bar{K}$            | 5.0             | 5                | 5     | 5       | ns   |
| t <sub>rec</sub> | Minimum Recovery Time, Set or Reset Inactive to Clock | 5.0             | 5                | 5     | 5       | ns   |
| t <sub>w</sub>   | Minimum Pulse Width, Set or Reset                     | 5.0             | 16               | 20    | 24      | ns   |
| t <sub>w</sub>   | Minimum Pulse Width, Clock                            | 5.0             | 16               | 20    | 24      | ns   |

# SWITCHING WAVEFORMS



Input and Output Threshold Voltage: V<sub>T</sub> = 50% V<sub>CC</sub> for HC, 1.3V for HCT, V<sub>H</sub> = V<sub>CC</sub> for HC, 3V for HCT