National Semiconductor

January 1988

# MM54HC533/MM74HC533 TRI-STATE® Octal D-Type Latch with Inverted Outputs

## General Description

These high speed OCTAL D-TYPE LATCHES utilize advanced silicon-gate CMOS technology. They possess the high noise immunity and low power consumption of standard CMOS integrated circuits, as well as the ability to drive 15 LS-TTL loads. Due to the large output drive capability and the TRI-STATE feature, these devices are ideally suited for interfacing with bus lines in a bus organized system.

When the LATCH ENABLE input is high, the data present on the D inputs will appear inverted at the $\overline{Q}$ outputs. When the LATCH ENABLE goes low, the inverted data will be retained at the $\overline{Q}$ outputs until LATCH ENABLE returns high again. When a high logic level is applied to the OUTPUT CONTROL input, all outputs go to a high impedance state, regardless of what signals are present at the other inputs and the state of the storage elements.

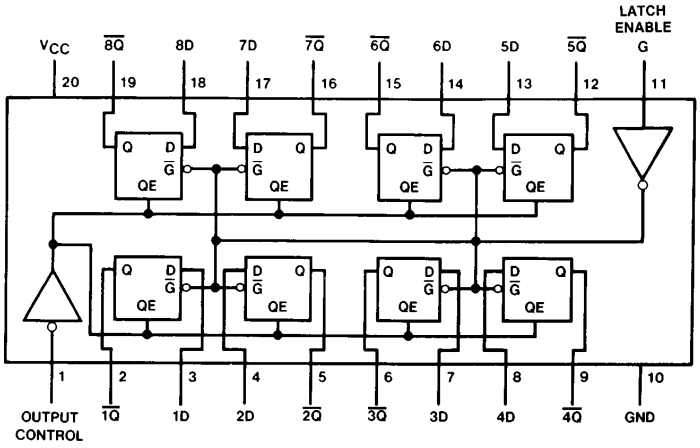
The 54HC/74HC logic family is speed, function, and pin-out compatible with the standard 54LS/74LS logic family. All inputs are protected from damage due to static discharge by internal diode clamps to $V_{CC}$ and ground.

## Features

- Typical propagation delay: 18 ns
- Wide operating voltage range: 2 to 6 volts
- Low input current: 1 $\mu$A maximum
- Low quiescent current: 80 $\mu$A, maximum (74HC Series)
- Compatible with bus-oriented systems
- Output drive capability: 15 LS-TTL loads

## Connection Diagram

**Dual-In-Line Package**




TL/F/5339–1

**Top View**

**Order Number MM54HC533 or MM74HC533**

## Truth Table

| Output Control | Latch Enable G | Data | Output |
|---|---|---|---|
| L | H | H | L |
| L | H | L | H |
| L | L | X | $\overline{Q}_0$ |
| H | X | X | Z |

H = high level, L = low level

$Q_0$ = level of output before steady-state input conditions were established.

Z = high impedance

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## Absolute Maximum Ratings (Notes 1 & 2)

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.**

| | |
|---|---|
| Supply Voltage ($V_{CC}$) | −0.5 to +7.0V |
| DC Input Voltage ($V_{IN}$) | −1.5 to $V_{CC}$ +1.5V |
| DC Output Voltage ($V_{OUT}$) | −0.5 to $V_{CC}$ +0.5V |
| Clamp Diode Current ($I_{IK}$, $I_{OK}$) | ±20 mA |
| DC Output Current, per pin ($I_{OUT}$) | ±35 mA |
| DC $V_{CC}$ or GND Current, per pin ($I_{CC}$) | ±70 mA |
| Storage Temperature Range ($T_{STG}$) | −65°C to +150°C |
| Power Dissipation ($P_D$) | |
| (Note 3) | 600 mW |
| S.O. Package only | 500 mW |
| Lead Temp. ($T_L$) (Soldering 10 seconds) | 260°C |

## Operating Conditions

| | Min | Max | Units |
|---|---|---|---|
| Supply Voltage ($V_{CC}$) | 2 | 6 | V |
| DC Input or Output Voltage ($V_{IN}$, $V_{OUT}$) | 0 | $V_{CC}$ | V |
| Operating Temp. Range ($T_A$) | | | |
| MM74HC | −40 | +85 | °C |
| MM54HC | −55 | +125 | °C |
| Input Rise or Fall Times ($t_r$, $t_f$) $V_{CC}$ = 2.0V | | 1000 | ns |
| $V_{CC}$ = 4.5V | | 500 | ns |
| $V_{CC}$ = 6.0V | | 400 | ns |

## DC Electrical Characteristics

| Symbol | Parameter | Conditions | $V_{CC}$ | $T_A$ = 25°C | 74HC $T_A$ = −40 to 85°C | 54HC $T_A$ = −55 to 125°C | Units |
|---|---|---|---|---|---|---|---|
| | | | | Typ | Guaranteed Limits | | |
| $V_{IH}$ | Minimum High Level Input Voltage | | 2.0V | | 1.5 | 1.5 | 1.5 | V |
| | | | 4.5V | | 3.15 | 3.15 | 3.15 | V |
| | | | 6.0V | | 4.2 | 4.2 | 4.2 | V |
| $V_{IL}$ | Maximum Low Level Input Voltage** | | 2.0V | | 0.5 | 0.5 | 0.5 | V |
| | | | 4.5V | | 1.35 | 1.35 | 1.35 | V |
| | | | 6.0V | | 1.8 | 1.8 | 1.8 | V |
| $V_{OH}$ | Minimum High Level Output Voltage | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ $\|I_{OUT}\| \leq 20\ \mu A$ | 2.0V | 2.0 | 1.9 | 1.9 | 1.9 | V |
| | | | 4.5V | 4.5 | 4.4 | 4.4 | 4.4 | V |
| | | | 6.0V | 6.0 | 5.9 | 5.9 | 5.9 | V |
| | | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ $\|I_{OUT}\| \leq 6.0$ mA | 4.5V | 4.2 | 3.98 | 3.84 | 3.7 | V |
| | | $\|I_{OUT}\| \leq 7.8$ mA | 6.0V | 5.7 | 5.48 | 5.34 | 5.2 | V |
| $V_{OL}$ | Maximum Low Level Output Voltage | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ $\|I_{OUT}\| \leq 20\ \mu A$ | 2.0V | 0 | 0.1 | 0.1 | 0.1 | V |
| | | | 4.5V | 0 | 0.1 | 0.1 | 0.1 | V |
| | | | 6.0V | 0 | 0.1 | 0.1 | 0.1 | V |
| | | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ $\|I_{OUT}\| \leq 6.0$ mA | 4.5V | 0.2 | 0.26 | 0.33 | 0.4 | V |
| | | $\|I_{OUT}\| \leq 7.8$ mA | 6.0V | 0.2 | 0.26 | 0.33 | 0.4 | V |
| $I_{IN}$ | Maximum Input Current | $V_{IN}$ = $V_{CC}$ or GND | 6.0V | | ±0.1 | ±1.0 | ±1.0 | μA |
| $I_{OZ}$ | Maximum TRI-STATE Output Leakage Current | $V_{IN}$ = $V_{IH}$ or $V_{IL}$, OC = $V_{IH}$ $V_{OUT}$ = $V_{CC}$ or GND | 6.0V | | ±0.5 | ±5 | ±10 | μA |
| $I_{CC}$ | Maximum Quiescent Supply Current | $V_{IN}$ = $V_{CC}$ or GND $I_{OUT}$ = 0 μA | 6.0V | | 8.0 | 80 | 160 | μA |

**Note 1:** Absolute Maximum Ratings are those values beyond which damage to the device may occur.

**Note 2:** Unless otherwise specified all voltages are referenced to ground.

**Note 3:** Power Dissipation temperature derating — plastic "N" package: −12 mW/°C from 65°C to 85°C; ceramic "J" package: −12 mW/°C from 100°C to 125°C.

**Note 4:** For a power supply of 5V ±10% the worst case output voltages ($V_{OH}$, and $V_{OL}$) occur for HC at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case $V_{IH}$ and $V_{IL}$ occur at $V_{CC}$ = 5.5V and 4.5V respectively. (The $V_{IH}$ value at 5.5V is 3.85V.) The worst case leakage current ($I_{IN}$, $I_{CC}$, and $I_{OZ}$) occur for CMOS at the higher voltage and so the 6.0V values should be used.

**$V_{IL}$ limits are currently tested at 20% of $V_{CC}$. The above $V_{IL}$ specification (30% of $V_{CC}$) will be implemented no later than Q1, CY'89.

## AC Electrical Characteristics $V_{CC} = 5V$, $T_A = 25°C$, $t_r = t_f = 6$ ns

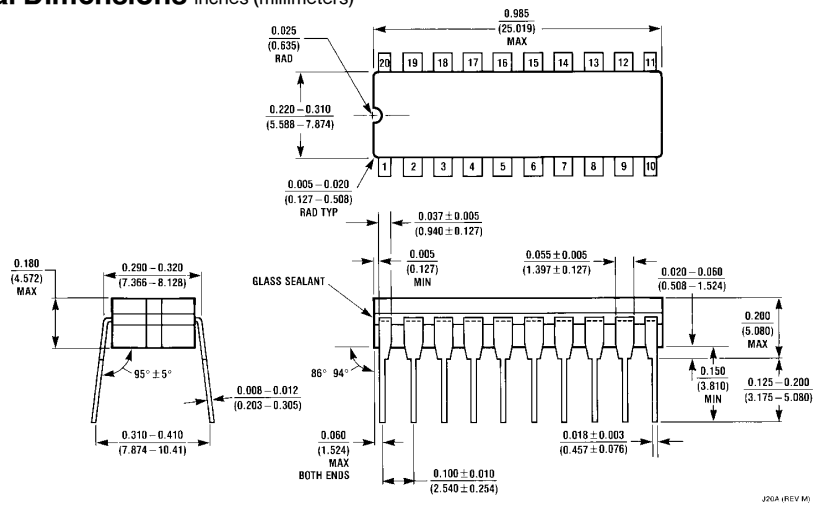
| Symbol | Parameter | Conditions | Typ | Guaranteed Limit | Units |
|---|---|---|---|---|---|
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation Delay, Data to $\overline{Q}$ | $C_L = 45$ pF | 18 | 25 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation Delay, Enable to $\overline{Q}$ | $C_L = 45$ pF | 21 | 30 | ns |
| $t_{PZH}$, $t_{PZL}$ | Maximum Output Enable Time | $R_L = 1$ kΩ<br>$C_L = 45$ pF | 20 | 28 | ns |
| $t_{PHZ}$, $t_{PLZ}$ | Maximum Output Disable Time | $R_L = 1$ kΩ<br>$C_L = 5$ pF | 18 | 25 | ns |
| $t_S$ | Minimum Set Up Time | | | 5 | ns |
| $t_H$ | Minimum Hold Time | | | 10 | ns |
| $t_W$ | Minimum Pulse Width | | | 16 | ns |

## AC Electrical Characteristics $V_{CC} = 2.0V–6.0V$, $C_L = 50$ pF, $t_r = t_f = 6$ ns (unless otherwise specified)

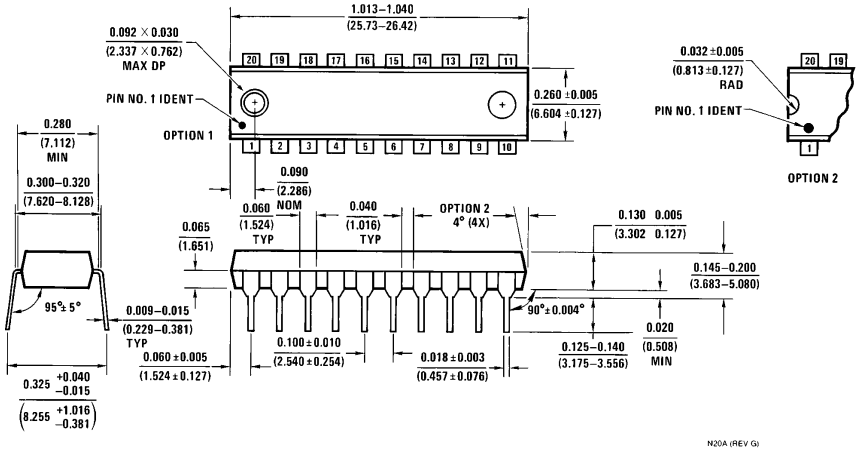
| Symbol | Parameter | Conditions | $V_{CC}$ | $T_A = 25°C$ | | 74HC $T_A = -40$ to $85°C$ | 54HC $T_A = -55$ to $125°C$ | Units |
|---|---|---|---|---|---|---|---|---|
| | | | | Typ | Guaranteed Limits | | | |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation Delay, Data to $\overline{Q}$ | $C_L = 50$ pF | 2.0V | 50 | 150 | 188 | 225 | ns |
| | | $C_L = 150$ pF | 2.0V | 80 | 200 | 250 | 300 | ns |
| | | $C_L = 50$ pF | 4.5V | 22 | 30 | 37 | 45 | ns |
| | | $C_L = 150$ pF | 4.5V | 30 | 40 | 50 | 60 | ns |
| | | $C_L = 50$ pF | 6.0V | 19 | 26 | 31 | 39 | ns |
| | | $C_L = 150$ pF | 6.0V | 26 | 35 | 44 | 53 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation Delay, Enable to $\overline{Q}$ | $C_L = 50$ pF | 2.0V | 63 | 175 | 220 | 263 | ns |
| | | $C_L = 150$ pF | 2.0V | 110 | 225 | 280 | 338 | ns |
| | | $C_L = 50$ pF | 4.5V | 25 | 35 | 44 | 52 | ns |
| | | $C_L = 150$ pF | 4.5V | 35 | 45 | 56 | 68 | ns |
| | | $C_L = 50$ pF | 6.0V | 21 | 30 | 37 | 45 | ns |
| | | $C_L = 150$ pF | 6.0V | 28 | 39 | 49 | 59 | ns |
| $t_{PZH}$, $t_{PZL}$ | Maximum Output Enable Time | $R_L = 1$ kΩ | | | | | | |
| | | $C_L = 50$ pF | 2.0V | 50 | 150 | 188 | 225 | ns |
| | | $C_L = 150$ pF | 2.0V | 80 | 200 | 250 | 300 | ns |
| | | $C_L = 50$ pF | 4.5V | 21 | 30 | 37 | 45 | ns |
| | | $C_L = 150$ pF | 4.5V | 30 | 40 | 50 | 60 | ns |
| | | $C_L = 50$ pF | 6.0V | 19 | 26 | 31 | 39 | ns |
| | | $C_L = 150$ pF | 6.0V | 26 | 35 | 44 | 53 | ns |
| $t_{PHZ}$, $t_{PLZ}$ | Maximum Output Disable Time | $R_L = 1$ kΩ<br>$C_L = 50$ pF | 2.0V | 50 | 150 | 188 | 225 | ns |
| | | | 4.5V | 21 | 30 | 37 | 45 | ns |
| | | | 6.0V | 19 | 26 | 31 | 39 | ns |
| $t_S$ | Minimum Set Up Time | | 2.0V | | 50 | 60 | 75 | ns |
| | | | 4.5V | | 9 | 13 | 15 | ns |
| | | | 6.0V | | 9 | 11 | 13 | ns |
| $t_H$ | Minimum Hold Time | | 2.0V | | 5 | 5 | 5 | ns |
| | | | 4.5V | | 5 | 5 | 5 | ns |
| | | | 6.0V | | 5 | 5 | 5 | ns |
| $t_W$ | Minimum Pulse Width | | 2.0V | 30 | 80 | 100 | 120 | ns |
| | | | 4.5V | 10 | 16 | 20 | 24 | ns |
| | | | 6.0V | 9 | 14 | 18 | 20 | ns |
| $t_{THL}$, $t_{TLH}$ | Maximum Output Rise and Fall Time, Clock | $C_L = 50$ pF | 2.0V | 25 | 60 | 75 | 90 | ns |
| | | | 4.5V | 7 | 12 | 15 | 18 | ns |
| | | | 6.0V | 6 | 10 | 13 | 15 | ns |
| $C_{PD}$ | Power Dissipation Capacitance (Note 5) | (per latch) | | | | | | |
| | | OC = $V_{CC}$ | | 30 | | | | pF |
| | | OC = Gnd | | 50 | | | | pF |
| $C_{IN}$ | Maximum Input Capacitance | | | 5 | 10 | 10 | 10 | pF |
| $C_{OUT}$ | Maximum Output Capacitance | | | 15 | 20 | 20 | 20 | pF |

**Note 5:** $C_{PD}$ determines the no load dynamic power consumption, $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$, and the no load dynamic current consumption, $I_S = C_{PD} V_{CC} f + I_{CC}$.

## Physical Dimensions inches (millimeters)




**Order Number MM54HC533J or MM74HC533J**
**NS Package J20A**




**Order Number MM74HC533N**
**NS Package N20A**

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