# TC74HC691AP/AF

**Synchronous Presettable 4-Bit Counter with Output Register (Multiplexed 3-State Outputs)**

**TC74HC691 Binary, Asynchronous clear**

The TC74HC691A is a high speed CMOS COUNTER/ REGISTER fabricated with silicon gate $C^2MOS$ technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

It is a 4-BIT BINARY COUNTER.

If the LOAD input ($\overline{LOAD}$) is held low, DATA input (A - D) are loaded in internal counter on the positive edge of the counter clock input (CCK). In counter mode, the internal counter counts up on the positive edge of counter clock. Counter clear input ($\overline{CCLR}$) is active low. The counter clear is asynchronous.

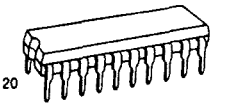
The internal counter's outputs are stored in the output register on the positive edge of register clock (RCK). Register clear ($\overline{RCLR}$) is active low. The register clear function is a synchronous to RCK. At this point, internal counter outputs do not change. The outputs (QA - QD) are selected from the internal counter outputs or register outputs by output select (R/$\overline{C}$).

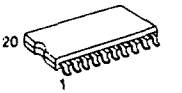
Two enable inputs (ENT and ENP) and carry output (RCO) are provided to enable easy cascading of counters without using external gate.

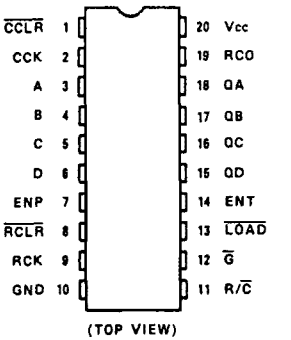
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

**Features**

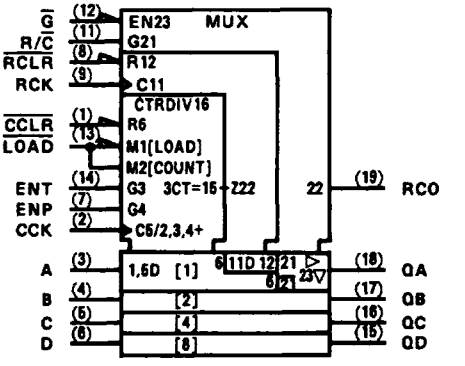
- High Speed: $f_{MAX}$ = 63MHz(Typ.) at $V_{CC}$ = 5V
- Low Power Dissipation: $I_{CC}$ = 4μA(Max.) at Ta = 25°C
- High Noise Immunity: $V_{NIH} = V_{NIL}$ = 28% $V_{CC}$ (Min)
- Output Drive Capability: 15 LSTTL Loads For QA ~ QH
  10 LSTTL Loads For RCO
- Symmetrical Output Impedance: $|I_{OH}| = I_{OL}$ = 6mA(Min.)
  For QA ~ QH
  $|I_{OH}| = I_{OL}$ = 4mA(Min.)
  For RCO
- Balanced Propagation Delays: $t_{pLH} = t_{pHL}$
- Wide Operating Voltage Range: $V_{CC}$(opr) = 2V ~ 6V
- Pin and Function Compatible with 74LS691




**Pin Assignment**

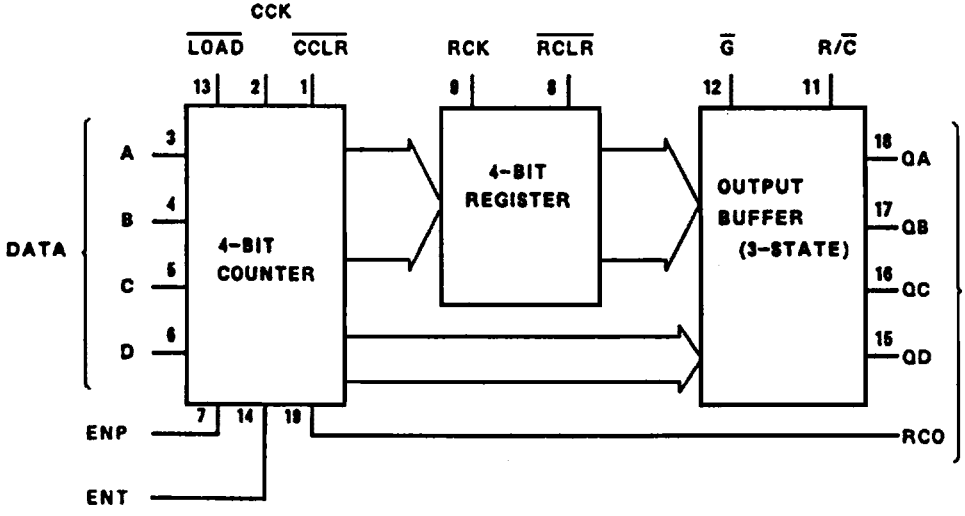


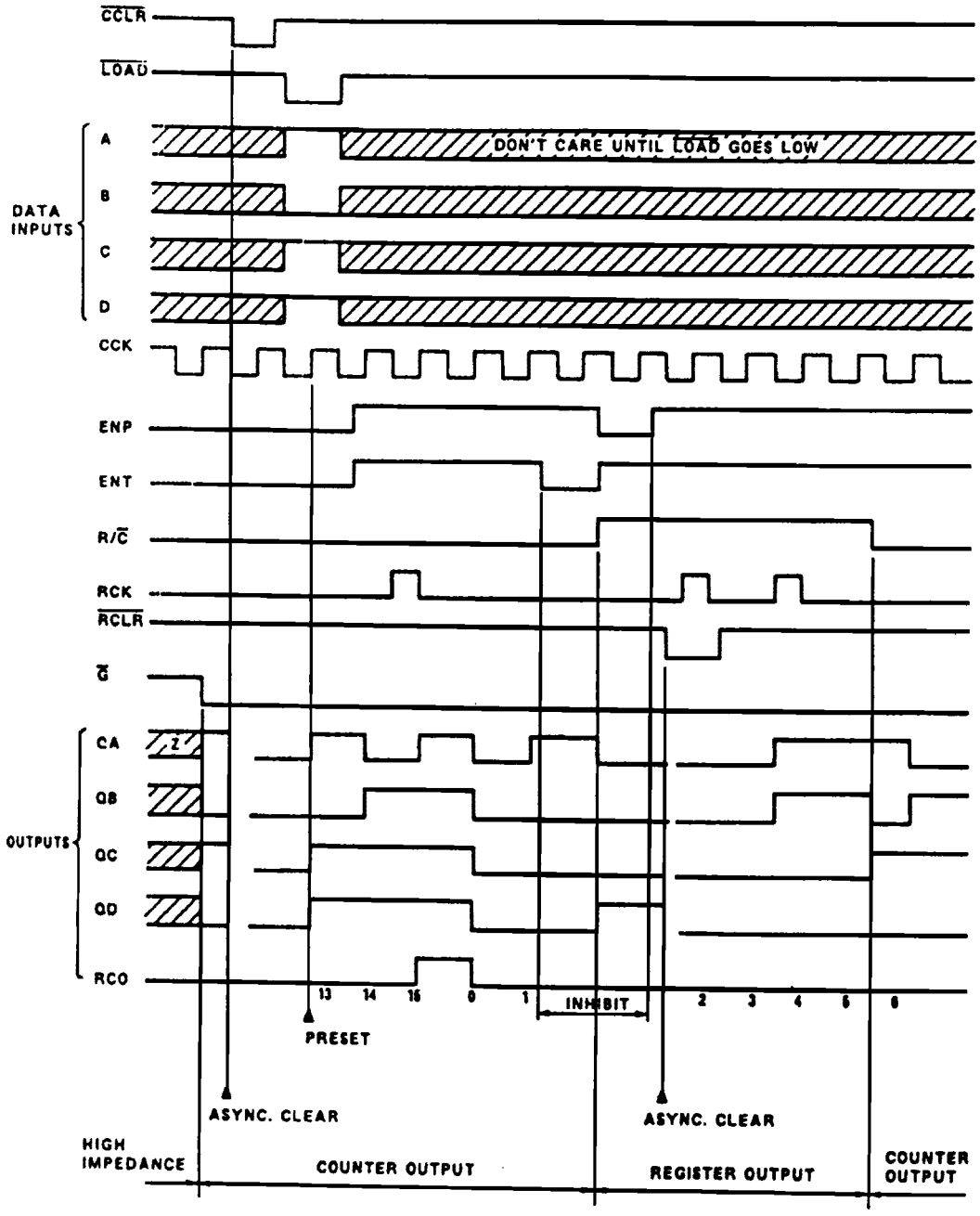

**IEC Logic Symbol**

## Truth Table

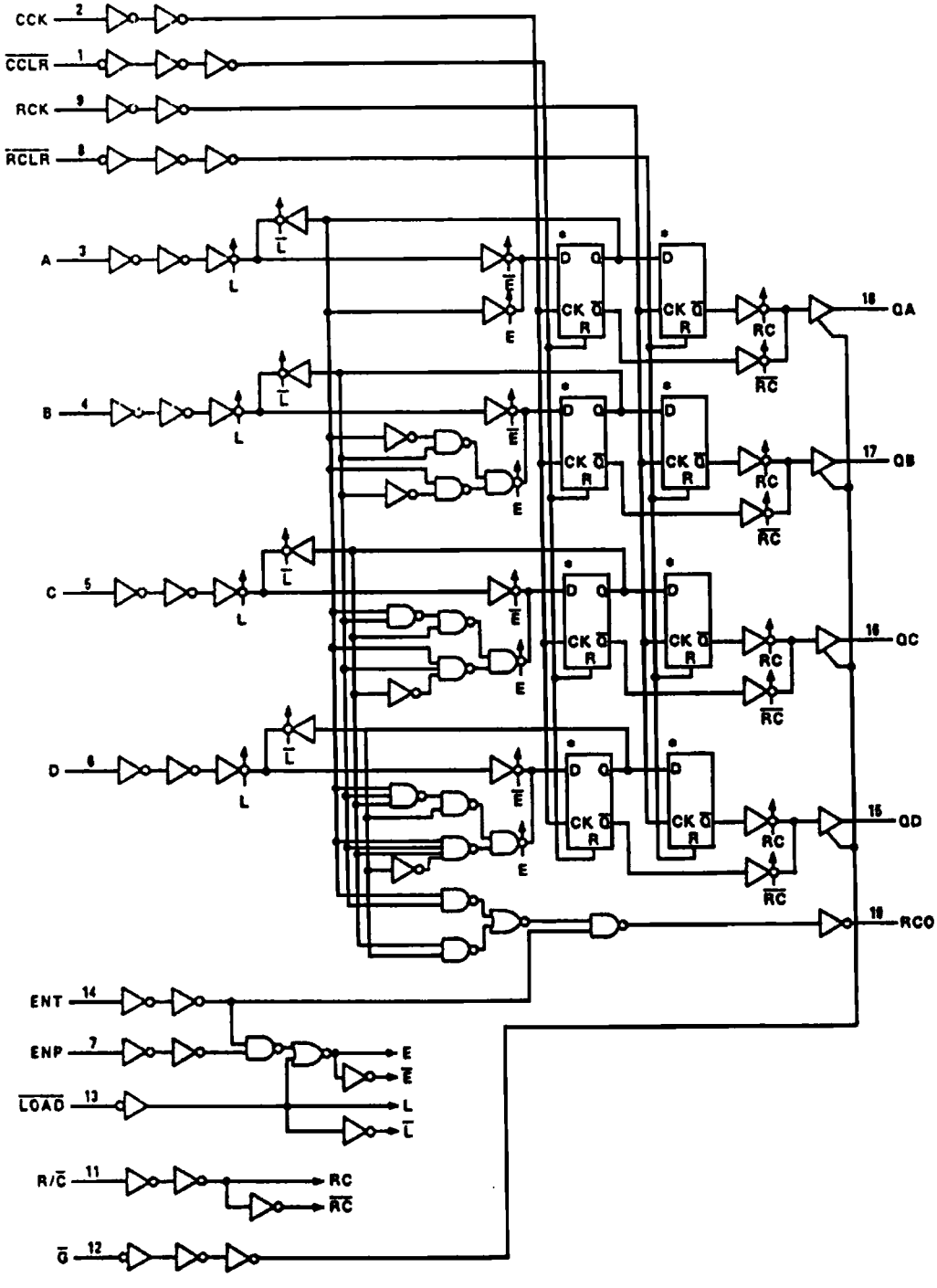
| Inputs | | | | | | | | | Outputs | | | | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\overline{CCLR}$ | LOAD | ENP | ENT | $\overline{RCLR}$ | CCK | RCK | R/$\overline{C}$ | $\overline{G}$ | QA | QB | QC | CD | |
| X | X | X | X | X | X | X | X | H | Z | Z | Z | | High Impedance |
| L | X | X | X | X | X | X | L | L | L | L | L | L | Counter Clear |
| H | L | X | X | X | ↑ | X | L | L | a | b | c | d | Load Data |
| H | H | L | X | X | ↑ | X | L | L | No change | | | | Count Disable |
| H | H | X | L | X | ↑ | X | L | L | | | | | No change |
| H | H | H | H | X | ↑ | X | L | L | Count up | | | | Count up |
| H | X | X | X | X | ↓ | X | L | L | No change | | | | No count |
| X | X | X | X | L | X | X | H | L | L | L | L | L | Register clear |
| X | X | X | X | H | X | ↑ | H | L | a' | b' | c' | d' | Load register |
| X | X | X | X | X | X | ↓ | G | L | No change | | | | No change |

X : Don't Care
Z : High Impedance
a ~ d: The level of steady state input voltage at inputs A~ D respectively.
a' ~ d': The level of internal counter outputs respectively, before the most recent positive edge of the register clock.






Timing Chart




Logic Diagram

## Absolute Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Supply Voltage Range | $V_{CC}$ | -0.5 ~ 7 | V |
| DC Input Voltage | $V_{IN}$ | -0.5 ~ $V_{CC}$ + 0.5 | V |
| DC Output Voltage | $V_{OUT}$ | -0.5 ~ $V_{CC}$ + 0.5 | V |
| Input Diode Current | $I_{IK}$ | ±20 | mA |
| Output Diode Current | $I_{OK}$ | ±20 | mA |
| DC Output Current (RCO) ($Q_A$ ~ $Q_H$) | $I_{OUT}$ | ±25<br>±35 | mA |
| DC $V_{CC}$/Ground Current | $I_{CC}$ | ±75 | mA |
| Power Dissipation | $P_D$ | 500(DIP)*/180(SOIC) | mW |
| Storage Temperature | $T_{stg}$ | -65 ~ 150 | °C |
| Lead Temperature 10sec | $T_L$ | 300 | °C |

*500mW in the range of Ta = -40°C ~ 65°C. From Ta = 65°C to 85°C a derating factor of -10mW/°C shall be applied until 300mW.

## Recommended Operating Conditions

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 2 ~ 6 | V |
| Input Voltage | $V_{IN}$ | 0 ~ $V_{CC}$ | V |
| Output Voltage | $V_{OUT}$ | 0 ~ $V_{CC}$ | V |
| Operating Temperature | $T_{opr}$ | -40 ~ 85 | °C |
| Input Rise and Fall Time | $t_r$, $t_f$ | 0 ~ 1000($V_{CC}$ = 2.0V)<br>0 ~ 500($V_{CC}$ = 4.5V)<br>0 ~ 400($V_{CC}$ = 6.0V) | ns |

## DC Electrical Characteristics

| Parameter | Symbol | Test Condition | | $V_{CC}$ | Ta = 25°C Min. | Ta = 25°C Typ. | Ta = 25°C Max. | Ta = -40 ~ 85°C Min. | Ta = -40 ~ 85°C Max. | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| High-Level Input Voltage | $V_{IH}$ | – | | 2.0<br>4.5<br>6.0 | 1.5<br>3.15<br>4.2 | –<br>–<br>– | –<br>–<br>– | 1.5<br>3.15<br>4.2 | –<br>–<br>– | V |
| Low-Level Input Voltage | $V_{IL}$ | – | | 2.0<br>4.5<br>6.0 | –<br>–<br>– | –<br>–<br>– | 0.5<br>1.35<br>1.8 | –<br>–<br>– | 0.5<br>1.35<br>1.8 | V |
| High-Level Output Voltage | $V_{OH}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = -20μA | 2.0<br>4.5<br>6.0 | 1.9<br>4.4<br>5.9 | 2.0<br>4.5<br>6.0 | –<br>–<br>– | 1.9<br>4.4<br>5.9 | –<br>–<br>– | V |
| | | RCO | $I_{OH}$ = -4 mA<br>$I_{OH}$ = -5.2mA | 4.5<br>6.0 | 4.18<br>5.68 | 4.31<br>5.80 | –<br>– | 4.13<br>5.63 | –<br>– | |
| | | $Q_A$ ~ $Q_H$ | $I_{OH}$ = -6 mA<br>$I_{OH}$ = -7.8mA | 4.5<br>6.0 | 4.18<br>5.68 | 4.31<br>5.80 | –<br>– | 4.13<br>5.63 | –<br>– | |
| Low-Level Output Voltage | $V_{OL}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 20μA | 2.0<br>4.5<br>6.0 | –<br>–<br>– | 0.0<br>0.0<br>0.0 | 0.1<br>0.1<br>0.1 | –<br>–<br>– | 0.1<br>0.1<br>0.1 | V |
| | | RCO | $I_{OH}$ = 4 mA<br>$I_{OH}$ = 5.2mA | 4.5<br>6.0 | –<br>– | 0.17<br>0.18 | 0.26<br>0.26 | –<br>– | 0.33<br>0.33 | |
| | | $Q_A$ ~ $Q_H$ | $I_{OL}$ = 6 mA<br>$I_{OL}$ = 7.8mA | 4.5<br>6.0 | –<br>– | 0.17<br>0.18 | 0.26<br>0.26 | –<br>– | 0.33<br>0.33 | |
| 3-State Output Off-State Current | $I_{OZ}$ | $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$V_{OUT}$ = $V_{CC}$ or GND | | 6.0 | – | – | ±0.5 | – | ±5.0 | μA |
| Input Leakage Current | $I_{IN}$ | $V_{IN}$ = $V_{CC}$ or GND | | 6.0 | – | – | ±0.1 | – | ±1.0 | |
| Quiescent Supply Current | $I_{CC}$ | $V_{IN}$ = $V_{CC}$ or GND | | 6.0 | – | – | 4.0 | – | 40.0 | |

## Timing Requirements (Input $t_r = t_f = 6ns$)

| Parameter | Symbol | Test Condition | | Ta = 25°C | | Ta = -40 ~ 85°C | Unit |
|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ | Typ. | Limit | Limit | |
| Minimum Pulse Width (CK) | $t_{W(H)}$ $t_{W(L)}$ | – | 2.0 | – | 75 | 95 | ns |
| | | | 4.5 | – | 15 | 19 | |
| | | | 6.0 | – | 12 | 15 | |
| Minimum Pulse Width ($\overline{CCLR}$, $\overline{RCLR}$) | $t_{W(L)}$ | – | 2.0 | – | 75 | 95 | |
| | | | 4.5 | – | 15 | 19 | |
| | | | 6.0 | – | 12 | 15 | |
| Minimum Setup Time ($\overline{CCLR}$, $\overline{RCLR}$) | $t_s$ | – | 2.0 | – | 100 | 125 | |
| | | | 4.5 | – | 20 | 25 | |
| | | | 6.0 | – | 16 | 20 | |
| Minimum Setup Time ($\overline{LOAD}$, ENT, ENP) | $t_s$ | – | 2.0 | – | 150 | 190 | |
| | | | 4.5 | – | 30 | 38 | |
| | | | 6.0 | – | 24 | 25 | |
| Minimum Setup Time (A, B, C, D) | $t_s$ | – | 2.0 | – | 125 | 155 | |
| | | | 4.5 | – | 25 | 31 | |
| | | | 6.0 | – | 20 | 25 | |
| Minimum Setup Time (CCK-RCK) | $t_s$ | – | 2.0 | – | 125 | 155 | |
| | | | 4.5 | – | 25 | 31 | |
| | | | 6.0 | – | 20 | 25 | |
| Minimum Hold Time | $t_h$ | – | 2.0 | – | 0 | 0 | |
| | | | 4.5 | – | 0 | 0 | |
| | | | 6.0 | – | 0 | 0 | |
| Minimum Removal Time | $t_{rem}$ | – | 2.0 | – | 50 | 65 | |
| | | | 4.5 | – | 10 | 13 | |
| | | | 6.0 | – | 8 | 10 | |
| Clock Frequency | f | – | 2.0 | – | 4 | 3.5 | MHz |
| | | | 4.5 | – | 22 | 18 | |
| | | | 6.0 | – | 26 | 21 | |

## AC Electrical Characteristics ($C_L = 15pF$, $V_{CC} = 5V$, Ta = 25°C)

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Output Transition Time (RCO) | $t_{TLH}$ $t_{THL}$ | – | – | 4 | 8 | ns |
| Propagation Delay Time (CCK-RCO) | $t_{pLH}$ $t_{pHL}$ | – | – | 18 | 32 | |
| Propagation Delay Time (ENT-RCO) | $t_{pLH}$ $t_{pHL}$ | – | – | 8 | 15 | |
| Propagation Delay Time ($\overline{CCLR}$-RCO) | $t_{pLH}$ | – | – | 19 | 34 | |
| Maximum Clock Frequency | $f_{MAX}$ | – | 24 | 63 | – | MHz |

## AC Electrical Characteristics ($C_L$ = 50pF, Input $t_r = t_f$ = 6ns)

| Parameter | Symbol | Test Condition | | | Ta = 25°C | | | Ta = -40 ~ 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | CL | $V_{CC}$ | Min. | Typ. | Max. | Min. | Max. | |
| Output Transition Time (Q) | $t_{TLH}$ $t_{THL}$ | – | 50 | 2.0 | – | 25 | 60 | – | 75 | ns |
| | | | | 4.5 | – | 7 | 12 | – | 15 | |
| | | | | 6.0 | – | 6 | 10 | – | 13 | |
| Output Transition Time (RCO) | $t_{TLH}$ $t_{THL}$ | – | 50 | 2.0 | – | 30 | 75 | – | 95 | |
| | | | | 4.5 | – | 8 | 15 | – | 19 | |
| | | | | 6.0 | – | 7 | 13 | – | 16 | |
| Propagation Delay Time (CCK-Q) | $t_{pLH}$ | – | 50 | 2.0 | – | 84 | 215 | – | 270 | |
| | | | | 4.5 | – | 27 | 43 | – | 54 | |
| | | | | 6.0 | – | 22 | 34 | – | 43 | |
| | $t_{pHL}$ | | 150 | 2.0 | – | 99 | 225 | – | 320 | |
| | | | | 4.5 | – | 32 | 51 | – | 64 | |
| | | | | 6.0 | – | 26 | 41 | – | 51 | |
| Propagation Delay Time (RCK-Q) | $t_{pLH}$ | – | 50 | 2.0 | – | 84 | 215 | – | 270 | |
| | | | | 4.5 | – | 28 | 43 | – | 54 | |
| | | | | 6.0 | – | 22 | 34 | – | 43 | |
| | $t_{pHL}$ | | 150 | 2.0 | – | 99 | 225 | – | 320 | |
| | | | | 4.5 | – | 33 | 51 | – | 64 | |
| | | | | 6.0 | – | 26 | 41 | – | 51 | |
| Propagation Delay Time (R/$\overline{C}$-Q) | $t_{pLH}$ | – | 50 | 2.0 | – | 63 | 170 | – | 215 | |
| | | | | 4.5 | – | 21 | 34 | – | 43 | |
| | | | | 6.0 | – | 17 | 27 | – | 34 | |
| | $t_{pHL}$ | | 150 | 2.0 | – | 78 | 210 | – | 265 | |
| | | | | 4.5 | – | 26 | 42 | – | 53 | |
| | | | | 6.0 | – | 21 | 34 | – | 42 | |
| Propagation Delay Time ($\overline{CCLR}$-Q) | $t_{pHL}$ | – | 50 | 2.0 | – | 93 | 250 | – | 315 | |
| | | | | 4.5 | – | 31 | 50 | – | 63 | |
| | | | | 6.0 | – | 25 | 40 | – | 50 | |
| | | | 150 | 2.0 | – | 108 | 290 | – | 365 | |
| | | | | 4.5 | – | 36 | 58 | – | 73 | |
| | | | | 6.0 | – | 29 | 46 | – | 58 | |
| Propagation Delay Time ($\overline{RCLR}$-Q) | $t_{pHL}$ | – | 50 | 2.0 | – | 90 | 250 | – | 315 | |
| | | | | 4.5 | – | 30 | 50 | – | 63 | |
| | | | | 6.0 | – | 24 | 40 | – | 50 | |
| | | | 150 | 2.0 | – | 105 | 290 | – | 365 | |
| | | | | 4.5 | – | 35 | 58 | – | 73 | |
| | | | | 6.0 | – | 28 | 46 | – | 58 | |
| Propagation Delay Time (CCK-RCO) | $t_{pLH}$ $t_{pHL}$ | – | 50 | 2.0 | – | 72 | 185 | – | 230 | |
| | | | | 4.5 | – | 23 | 37 | – | 46 | |
| | | | | 6.0 | – | 19 | 30 | – | 37 | |
| Propagation Delay Time (ENT-RCO) | $t_{pLH}$ $t_{pHL}$ | – | 50 | 2.0 | – | 36 | 95 | – | 120 | |
| | | | | 4.5 | – | 12 | 19 | – | 24 | |
| | | | | 6.0 | – | 10 | 15 | – | 19 | |
| Propagation Delay Time ($\overline{CCLR}$-RCO) | $t_{pHL}$ | – | 50 | 2.0 | – | 75 | 195 | – | 245 | |
| | | | | 4.5 | – | 25 | 39 | – | 49 | |
| | | | | 6.0 | – | 20 | 31 | – | 39 | |
| Output Enable Time ($\overline{G}$-Q) | $t_{pZL}$ | $R_L$ = 1k Ω | 50 | 2.0 | – | 48 | 120 | – | 150 | |
| | | | | 4.5 | – | 16 | 24 | – | 30 | |
| | | | | 6.0 | – | 13 | 19 | – | 24 | |
| | $t_{pZH}$ | | 150 | 2.0 | – | 63 | 160 | – | 200 | |
| | | | | 4.5 | – | 21 | 32 | – | 40 | |
| | | | | 6.0 | – | 17 | 26 | – | 32 | |
| Output Disable Time ($\overline{G}$-Q) | $t_{pLZ}$ $t_{pHZ}$ | $R_L$ = 1k Ω | 50 | 2.0 | – | 34 | 145 | – | 180 | |
| | | | | 4.5 | – | 18 | 29 | – | 36 | |
| | | | | 6.0 | – | 14 | 23 | – | 29 | |

## AC Electrical Characteristics ($C_L$ = 50pF, Input $t_r = t_f$ = 6ns)

| Parameter | Symbol | Test Condition | | | Ta = 25°C | | | Ta = -40 ~ 85°C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | CL | $V_{CC}$ | Min. | Typ. | Max. | Min. | Max. | |
| Maximum Clock Frequency | $f_{MAX}$ | – | 50 | 2.0<br>4.5<br>6.0 | 4<br>22<br>26 | 17<br>52<br>65 | –<br>–<br>– | 3.5<br>18<br>21 | –<br>–<br>– | MHz |
| Input Capacitance | $C_{IN}$ | – | | | – | 5 | 10 | – | 10 | pF |
| Output Capacitance | $C_{OUT}$ | – | | | – | 13 | – | – | – | |
| Power Dissipation Capacitance | $C_{PD}$(1) | – | | | – | 63 | – | – | – | |

Note (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:

$I_{CC(opr)} = C_{PD} \bullet V_{CC} \bullet f_{IN} + I_{CC}$