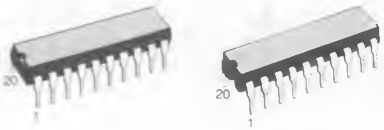
SGS-THOMSON MICROELECTRONICS

# M54/74HC299
# M74/74HC323

## HC299 8-BIT PIPO SHIFT REGISTER WITH ASYNCHRONOUS CLEAR
## HC323 8-BIT PIPO SHIFT REGISTER WITH SYNCRONOUS CLEAR

- LOW POWER DISSIPATION
  $I_{CC}$ = 4 $\mu$A (MAX.) at $T_A$ = 25°C
- HIGH NOISE IMMUNITY
  $V_{NIH}$ = $V_{NIL}$ = 28% $V_{CC}$ (Min.)
- OUTPUT DRIVE CAPABILITY
  10 LSTTL LOADS
- SYMMETRICAL OUTPUT IMPEDANCE
  $|I_{OH}|$ = $I_{OL}$ = 6 mA (MIN.) for $Q_A$, to $Q_H$,
  $|I_{OH}|$ = $I_{OL}$ = 4 mA (MIN.) for $Q_A$, to $Q_H$
- BALANCED PROPAGATION DELAYS
  $t_{PLH}$ = $t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE
  $V_{CC}$ (OPR) = 2V to 6V
- PIN AND FUNCTION COMPATIBLE
  WITH 54/74LS299



**B1N**
Plastic Package

**F1**
Ceramic Frit Seal Package

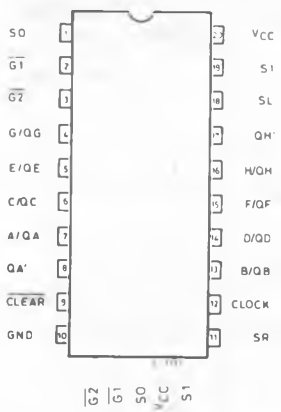
**M1**
Micro Package

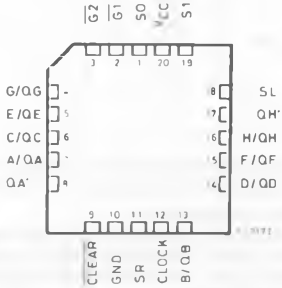
**C1**
Plastic Chip Carrier

ORDERING NUMBERS:

M54HCTXXX F1
M74HCTXXX B1N
M74HCTXXX F1
M74HCTXXX C1
M74HCTXXX M1

**PIN CONNECTIONS** (top view)



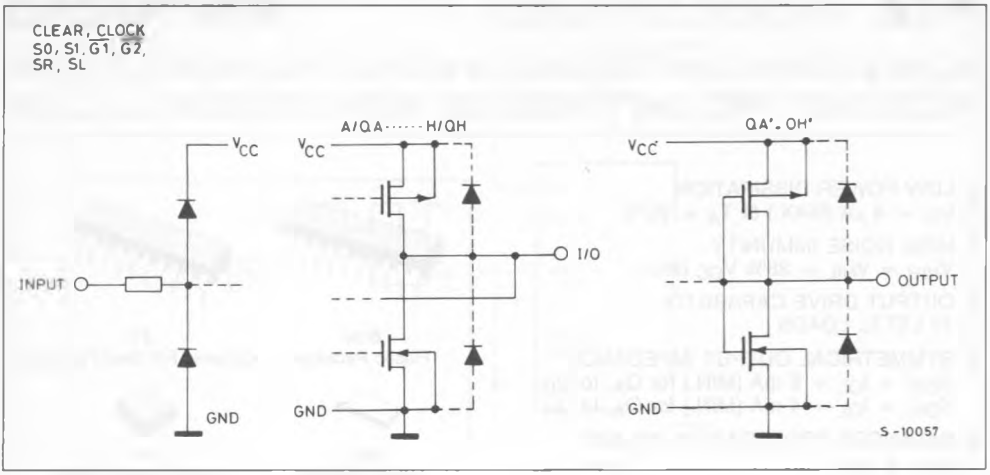




NC =
No Internal
Connection

### DESCRIPTION

The M54/74HC299/323 are high speed CMOS 8-BIT PIPO SHIFT REGISTERS (3-STATE) fabricated with silicon gate C²MOS technology.
They achieve the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power consumption.
These devices have four modes (HOLD, SHIFT LEFT, SHIFT RIGH and LOAD DATA). Each mode is chosen by two function select inputs (S0, S1). When one or both enable inputs, (G1, G2) are high, the eight input/output terminals are in the high-impedance state; however sequential operation or clearing of the register is not affected.
Clear function on the HC299 is asynchronous to CLOCK, while the HC323 is cleared synchronous to clock.
All inputs are equipped with protection circuits against static discharge and transient excess voltage.

## INPUT AND OUTPUT EQUIVALENT CIRCUIT



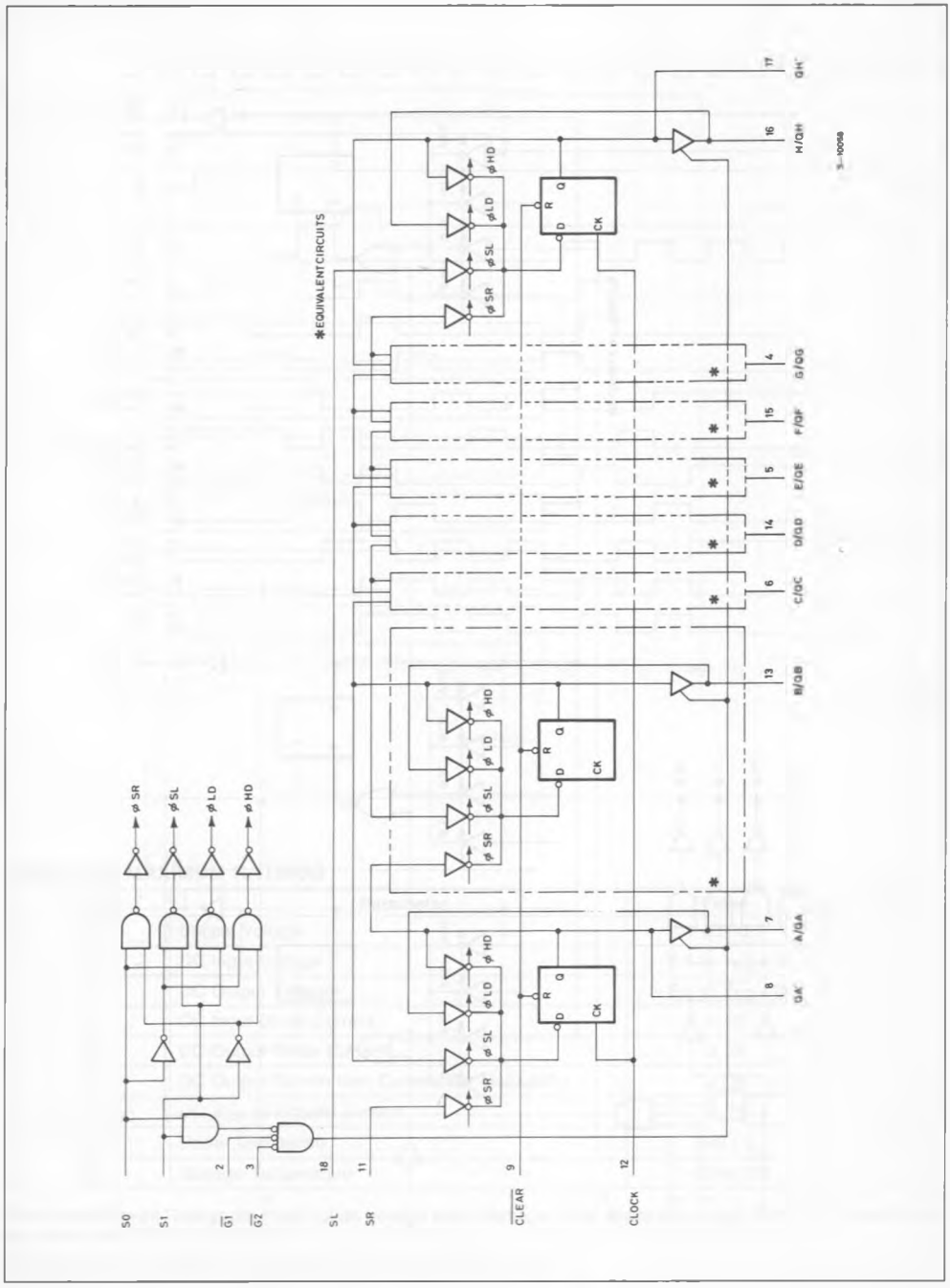

## TRUTH TABLE

| MODE | INPUTS | | | | | | | INPUTS/OUTPUTS | | | | OUTPUTS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\overline{CLEAR}$ | FUNCTION SELECT | | OUTPUT CONTROL | | CLOCK | | SERIAL | | A/QA | H/QH | QA' | QH' |
| | | S1 | S0 | $\overline{G1}$* | $\overline{G2}$* | (299) | (323) | SL | SR | | | | |
| Z | L | H | H | X | X | X | | X | X | Z | Z | L | L |
| CLEAR | L | L | X | L | L | X | ↑ | X | X | L | L | L | L |
| | L | X | L | L | L | X | ↑ | X | X | L | L | L | L |
| HOLD | H | L | L | L | L | X | | X | X | QA0 | QH0 | QA0 | QH0 |
| SHIFT RIGHT | H | L | H | L | L | ↑ | | X | H | H | QGn | H | QGn |
| | H | L | H | L | L | ↑ | | X | L | L | QGn | L | QGn |
| SHIFT LEFT | H | H | L | L | L | ↑ | | H | X | QBn | H | QBn | H |
| | H | H | L | L | L | ↑ | | L | X | QBn | L | QBn | L |
| LOAD | H | H | H | X | X | ↑ | | X | X | a | h | a | h |

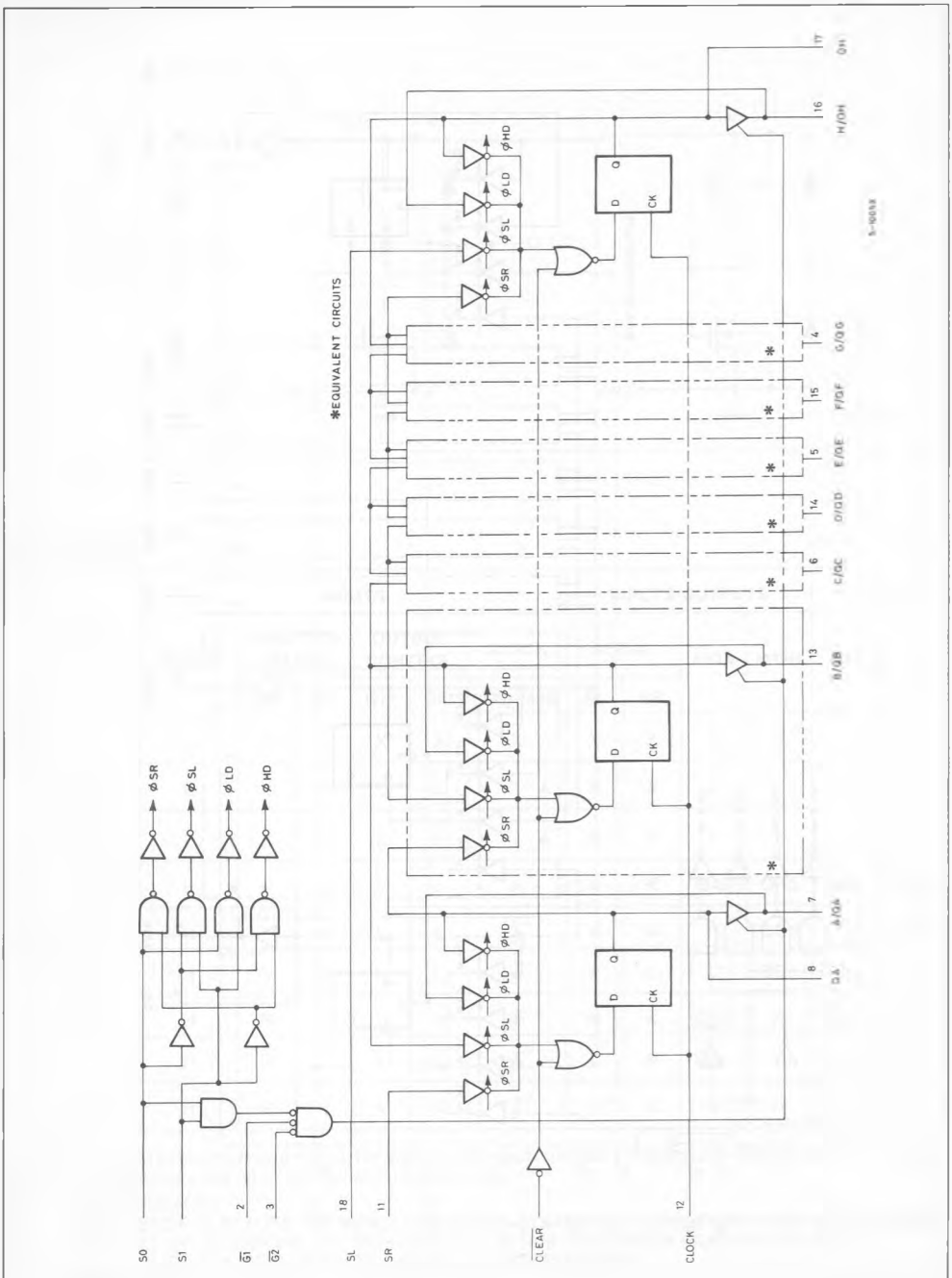
* When one or both output controls are high, the eight, input/output terminals are in the high-impedance state; however sequential operation or clearing of the register is not affected.

Z : HIGH IMPEDANCE
Qno : THE LEVEL OF An BEFORE THE INDICATED STEADY-STATE INPUT CONDITIONS WERE ESTABLISHED.
Qnn : THE LEVEL OF Qn BEFORE THE MOST RECENT ACTIVE TRANSITION INDICATED BY ↓ OR ↑
a,h : THE LEVEL OF THE STEADY-STATE INPUTS A, H, RESPECTIVELY.
X : DON'T CARE

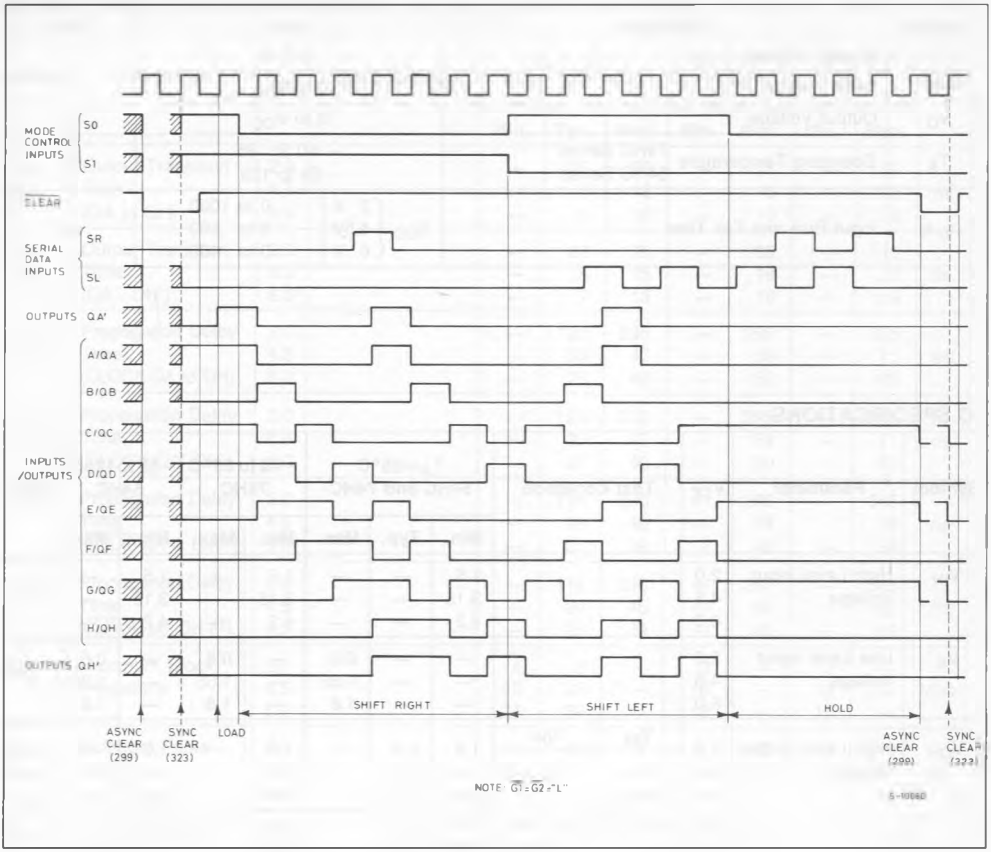
**LOGIC DIAGRAM** (HC299)



## LOGIC DIAGRAM (HC323)



## TIMING CHART




## ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply Voltage | − 0.5 to 7 | V |
| $V_I$ | DC Input Voltage | − 0.5 to $V_{CC}$ + 0.5 | V |
| $V_O$ | DC Output Voltage | − 0.5 to $V_{CC}$ + 0.5 | V |
| $I_{IK}$ | DC Input Diode Current | ± 20 | mA |
| $I_{OK}$ | DC Output Diode Current | ± 20 | mA |
| $I_O$ | DC Output Source Sink Current Per Output Pin | ± 35 | mA |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | ± 70 | mA |
| $P_D$ | Power Dissipation | 500 (*) | mW |
| $T_{stg}$ | Storage Temperature | − 65 to 150 | °C |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

(*) 500 mW: ≡ 65°C derate to 300 mW by 10 mW/°C: 65°C to 85°C

## RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | | Value | | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | | 2 to 6 | | V |
| $V_I$ | Input Voltage | | 0 to $V_{CC}$ | | V |
| $V_O$ | Output Voltage | | 0 to $V_{CC}$ | | V |
| $T_A$ | Operating Temperature | 74HC Series<br>54HC Series | – 40 to 85<br>– 55 to 125 | | °C |
| $t_r$, $t_f$ | Input Rise and Fall Time | | $V_{CC}$ = 2 V | 0 to 1000 | ns |
| | | | $V_{CC}$ = 4.5V | 0 to 500 | |
| | | | $V_{CC}$ = 6 V | 0 to 400 | |

## DC SPECIFICATIONS

| Symbol | Parameter | $V_{CC}$ | Test Condition | | $T_A$ = 25°C 54HC and 74HC | | | – 40 to 85°C 74HC | | – 55 to 125°C 54HC | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $V_{IH}$ | High Level Input Voltage | 2.0 | | | 1.5 | — | — | 1.5 | — | 1.5 | — | V |
| | | 4.5 | | | 3.15 | — | — | 3.15 | — | 3.15 | — | |
| | | 6.0 | | | 4.2 | — | — | 4.2 | — | 4.2 | — | |
| $V_{IL}$ | Low Level Input Voltage | 2.0 | | | — | — | 0.5 | — | 0.5 | — | 0.5 | V |
| | | 4.5 | | | — | — | 1.35 | — | 1.35 | — | 1.35 | |
| | | 6.0 | | | — | — | 1.8 | — | 1.8 | — | 1.8 | |
| $V_{OH}$ | High Level Output Voltage | 2.0 | $V_{IN}$ | $I_{OH}$ | 1.9 | 2.0 | — | 1.9 | — | 1.9 | — | V |
| | | 4.5 | $V_{IH}$ or $V_{IL}$ | – 20 μA | 4.4 | 4.5 | — | 4.4 | — | 4.4 | — | |
| | | 6.0 | | | 5.9 | 6.0 | — | 5.9 | — | 5.9 | — | |
| | | 4.5 | $Q_A$ to $Q_H$ | – 6.0 mA | 4.18 | 4.31 | — | 4.13 | — | 4.10 | — | |
| | | 6.0 | | – 7.8 mA | 5.68 | 5.8 | — | 5.63 | — | 5.60 | — | |
| | | 4.5 | $Q_A'$, $Q_H'$ | – 4.0 mA | 4.18 | 4.31 | — | 4.13 | — | 4.10 | — | |
| | | 6.0 | | – 5.2 mA | 5.68 | 5.8 | — | 5.63 | — | 5.60 | — | |
| $V_{OL}$ | Low Level Output Voltage | 2.0 | $V_{IN}$ | $I_{OL}$ | — | 0 | 0.1 | — | 0.1 | — | 0.1 | V |
| | | 4.5 | $V_{IH}$ or $V_{IL}$ | 20 μA | — | 0 | 0.1 | — | 0.1 | — | 0.1 | |
| | | 6.0 | | | — | 0 | 0.1 | — | 0.1 | — | 0.1 | |
| | | 4.5 | $Q_A$ to $Q_H$ | 6.0 mA | — | 0.17 | 0.26 | — | 0.33 | — | 0.40 | |
| | | 6.0 | | 7.8 mA | — | 0.18 | 0.26 | — | 0.33 | — | 0.40 | |
| | | 4.5 | $Q_A'$, $Q_H'$ | 4.0 mA | — | 0.17 | 0.26 | — | 0.33 | — | 0.40 | |
| | | 6.0 | | 5.2 mA | — | 0.18 | 0.26 | — | 0.33 | — | 0.40 | |
| $I_{OZ}$ | 3-State Output Off-State Current | 6.0 | $V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$V_{OUT}$ = $V_{CC}$ or GND | | — | — | ± 0.5 | — | ± 5.0 | — | ± 10 | μA |
| $I_{IN}$ | Input Leakage Current | 6.0 | $V_{IN}$ = $V_{CC}$ or GND | | — | — | ± 0.1 | — | ± 1.0 | — | ± 1.0 | |
| $I_{CC}$ | Quiescent Supply Current | 6.0 | $V_{IN}$ = $V_{CC}$ or GND | | — | — | 4 | — | 40 | — | 80 | |

**AC ELECTRICAL CHARACTERISTICS** ($C_L$ = 50pF, Input $t_r = t_f$ = 6ns)

| Symbol | Parameter | $V_{CC}$ | Test Condition | $T_A$ = 25°C 54HC and 74HC | | | −40 to 85°C 74HC | | −55 to 125°C 54HC | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $t_{TLH}$ $t_{THL}$ | Output Transition Time (QA to QH) | 2.0 | | — | 25 | 60 | — | 75 | — | 90 | ns |
| | | 4.5 | | — | 7 | 12 | — | 15 | — | 18 | |
| | | 6.0 | | — | 6 | 10 | — | 13 | — | 15 | |
| $t_{TLH}$ $t_{THL}$ | Output Transition Time (QA', QH') | 2.0 | | — | 30 | 75 | — | 95 | — | 110 | ns |
| | | 4.5 | | — | 8 | 15 | — | 19 | — | 22 | |
| | | 6.0 | | — | 7 | 13 | — | 16 | — | 19 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (CLOCK-QA to QH) | 2.0 | | — | 120 | 235 | — | 295 | — | 355 | ns |
| | | 4.5 | | — | 30 | 47 | — | 59 | — | 71 | |
| | | 6.0 | | — | 26 | 40 | — | 50 | — | 60 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (CLOCK-QA',QH') | 2.0 | | — | 120 | 235 | — | 295 | — | 345 | ns |
| | | 4.5 | | — | 30 | 47 | — | 59 | — | 71 | |
| | | 6.0 | | — | 26 | 40 | — | 50 | — | 60 | |
| $t_{PHL}$ | Propagation Delay Time ($\overline{CLEAR}$-QA to QH)(1) | 2.0 | | — | 116 | 230 | — | 290 | — | 345 | ns |
| | | 4.5 | | — | 29 | 46 | — | 58 | — | 69 | |
| | | 6.0 | | — | 25 | 39 | — | 49 | — | 59 | |
| $t_{PHL}$ | Propagation Delay Time ($\overline{CLEAR}$-QA', QH')(1) | 2.0 | | — | 116 | 230 | — | 290 | — | 345 | ns |
| | | 4.5 | | — | 29 | 46 | — | 58 | — | 69 | |
| | | 6.0 | | — | 25 | 39 | — | 49 | — | 59 | |
| $f_{MAX}$ | Maximum Clock Frequency | 2.0 | | 4 | 8 | — | 3 | — | 3 | — | MHz |
| | | 4.5 | | 20 | 33 | — | 16 | — | 13 | — | |
| | | 6.0 | | 24 | 39 | — | 19 | — | 15 | — | |
| $t_{W(H)}$ $t_{W(L)}$ | Minimum Pulse Width (CLOCK) | 2.0 | | — | 30 | 75 | — | 95 | — | 110 | ns |
| | | 4.5 | | — | 8 | 15 | — | 19 | — | 22 | |
| | | 6.0 | | — | 7 | 13 | — | 16 | — | 19 | |
| $t_{W(L)}$ | Minimum Pulse Width $\overline{CLEAR}$ | 2.0 | | — | 50 | 100 | — | 125 | — | 150 | ns |
| | | 4.5 | | — | 12 | 20 | — | 25 | — | 30 | |
| | | 6.0 | | — | 10 | 17 | — | 21 | — | 26 | |
| $t_s$ | Minimum Set-up Time (SL, SR, A to H) | 2.0 | | — | 25 | 75 | — | 95 | — | 110 | ns |
| | | 4.5 | | — | 6 | 15 | — | 19 | — | 22 | |
| | | 6.0 | | — | 5 | 13 | — | 16 | — | 19 | |
| $t_s$ | Minimum Set-up Time (S0, S1) | 2.0 | | — | 50 | 125 | — | 155 | — | 190 | ns |
| | | 4.5 | | — | 13 | 25 | — | 31 | — | 38 | |
| | | 6.0 | | — | 11 | 21 | — | 26 | — | 32 | |
| $t_s$ | Minimum Set-up Time ($\overline{CLEAR}$) (2) | 2.0 | | — | 32 | 75 | — | 95 | — | 110 | ns |
| | | 4.5 | | — | 8 | 15 | — | 19 | — | 22 | |
| | | 6.0 | | — | 7 | 13 | — | 16 | — | 19 | |
| $t_h$ | Minimum Hold Time (SL, SR, A to H) | 2.0 | | — | — | 0 | — | 0 | — | 0 | ns |
| | | 4.5 | | — | — | 0 | — | 0 | — | 0 | |
| | | 6.0 | | — | — | 0 | — | 0 | — | 0 | |
| $t_h$ | Minimum Hold Time (S0, S1) | 2.0 | | — | — | 0 | — | 0 | — | 0 | ns |
| | | 4.5 | | — | — | 0 | — | 0 | — | 0 | |
| | | 6.0 | | — | — | 0 | — | 0 | — | 0 | |

(1) Apply to M54/74HC299
(2) Apply to M54/74HC323

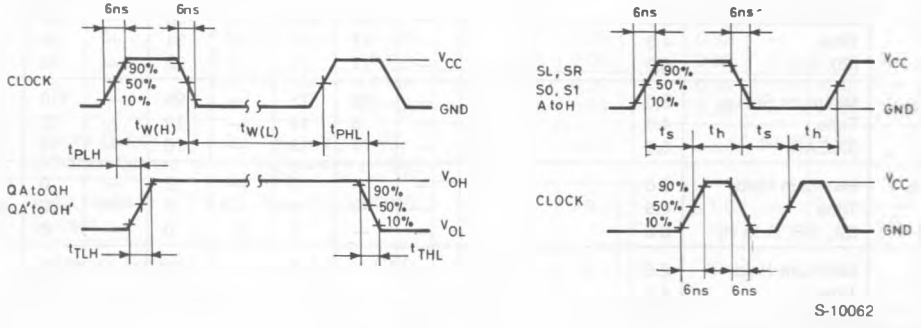
## AC ELECTRICAL CHARACTERISTICS (Continued)

| Symbol | Parameter | $V_{CC}$ | Test Condition | $T_A = 25°C$ 54HC and 74HC | | | − 40 to 85°C 74HC | | − 55 to 125°C 54HC | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $t_h$ | Minimum Hold Time ($\overline{CLEAR}$) (2) | 2.0 | | — | — | 0 | — | 0 | — | 0 | ns |
| | | 4.5 | | — | — | 0 | — | 0 | — | 0 | |
| | | 6.0 | | — | — | 0 | — | 0 | — | 0 | |
| $t_{REM}$ | Minimum Removal Time ($\overline{CLEAR}$) (1) | 2.0 | | — | — | 25 | — | 30 | — | 40 | ns |
| | | 4.5 | | — | — | 5 | — | 6 | — | 8 | |
| | | 6.0 | | — | — | 5 | — | 6 | — | 7 | |
| $t_{PZL}$ $t_{PZH}$ | 3-State Output Enable Time | 2.0 | $R_L = 1k\Omega$ | — | 100 | 195 | — | 245 | — | 295 | ns |
| | | 4.5 | | — | 25 | 39 | — | 49 | — | 59 | |
| | | 6.0 | | — | 21 | 33 | — | 42 | — | 50 | |
| $t_{PLZ}$ $t_{PHZ}$ | 3-State Output Disable Time | 2.0 | $R_L = 1k\Omega$ | — | 112 | 200 | — | 250 | — | 300 | ns |
| | | 4.5 | | — | 28 | 40 | — | 50 | — | 60 | |
| | | 6.0 | | — | 24 | 34 | — | 43 | — | 51 | |
| $C_{IN}$ | Input Capacitance | | | — | 5 | 10 | — | 10 | — | 10 | pF |
| $C_{OUT}$ | Output Capacitance (QA to QH) | | | — | 13 | — | — | — | — | — | pF |
| $C_{PD}$ (*) | Power Dissipation Capacitance | | | — | 221 | — | — | — | — | — | pF |

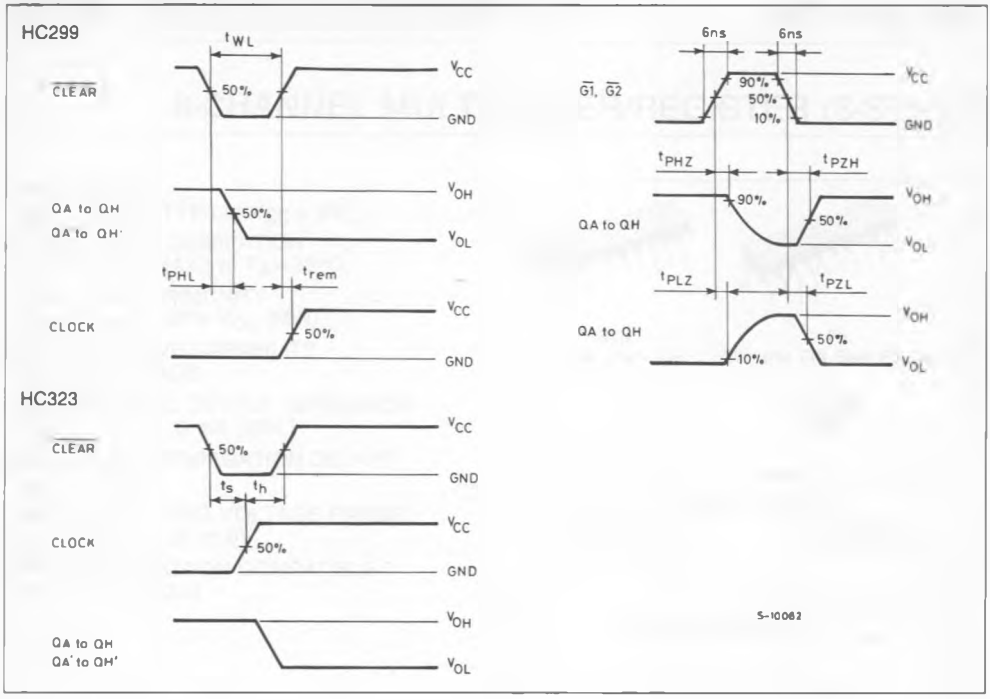
Note (*) $C_{PD}$ is defined as the value of internal equivalent capacitance of IC which is calculated from the operating current consumption without load (refer to Test circuit).
Average opeating current can be obtained from the equation:
$I_{CC(opr.)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$

(1) Apply to M54/74HC299
(2) Apply to M54/74HC323

## SWITCHING CHARACTERISTICS TEST WAVEFORM



## SWITCHING CHARACTERISTICS TEST WAVEFORM (Continued)




## TEST CIRCUIT $I_{CC}$ (Opr.)