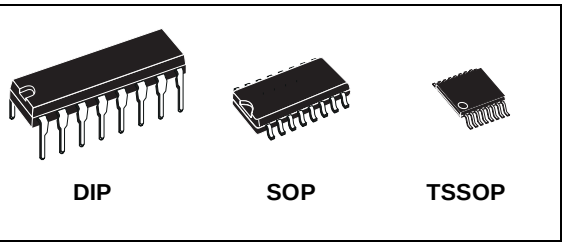
# M74HC165

## 8 BIT PISO SHIFT REGISTER

- HIGH SPEED :
  $t_{PD}$ = 15ns (TYP.) at $V_{CC}$ = 6V
- LOW POWER DISSIPATION:
  $I_{CC}$ =4μA(MAX.) at $T_A$=25°C
- HIGH NOISE IMMUNITY:
  $V_{NIH} = V_{NIL}$ = 28 % $V_{CC}$ (MIN.)
- SYMMETRICAL OUTPUT IMPEDANCE:
  $|I_{OH}| = I_{OL}$ = 4mA (MIN)
- BALANCED PROPAGATION DELAYS:
  $t_{PLH} \cong t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE:
  $V_{CC}$ (OPR) = 2V to 6V
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 165



**DIP** **SOP** **TSSOP**

**ORDER CODES**

| PACKAGE | TUBE | T & R |
|---|---|---|
| DIP | M74HC165B1R | |
| SOP | M74HC165M1R | M74HC165RM13TR |
| TSSOP | | M74HC165TTR |

**DESCRIPTION**

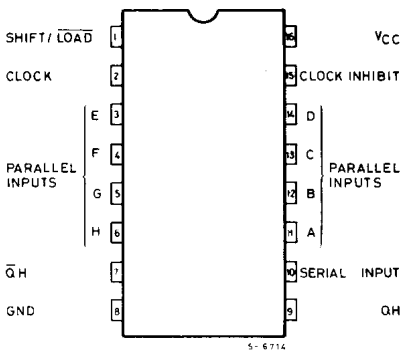
The M74HC165 is an high speed CMOS 8 BIT PISO SHIFT REGISTER fabricated with silicon gate $C^2MOS$ technology.

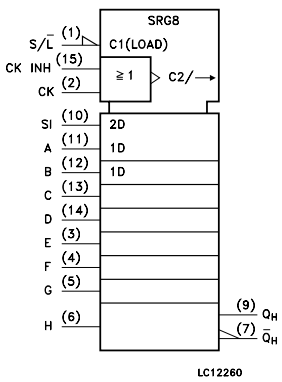
This device contains eight clocked master slave RS flip-flops connected as a shift register, with auxiliary gating to provide over-riding asynchronous parallel entry. Parallel data enters when the shift/load input is low. The parallel data can change while shift/load is low, provided that the recommended set-up and hold times are observed. For clocked operation, shift/load must be high. The two clock input perform identically; one can be used as a clock inhibit by applying a high signal; to permit this operation clocking is accomplished through a 2 input nor gate.

To avoid double clocking, however, the inhibit signal should only go high while the clock is high. Otherwise the rising inhibit signal will cause the same response as rising clock edge.

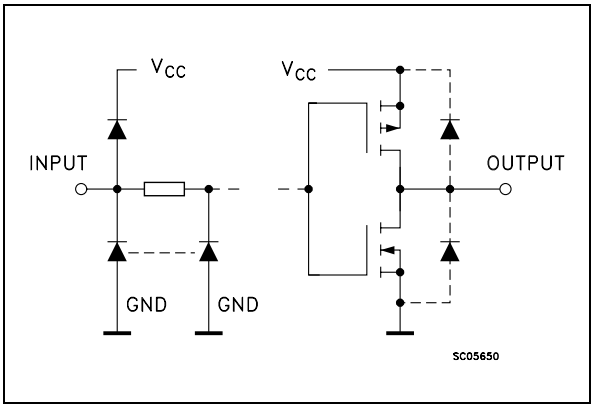
All inputs are equipped with protection circuits against static discharge and transient excess voltage.

**PIN CONNECTION AND IEC LOGIC SYMBOLS**



## INPUT AND OUTPUT EQUIVALENT CIRCUIT




## PIN DESCRIPTION

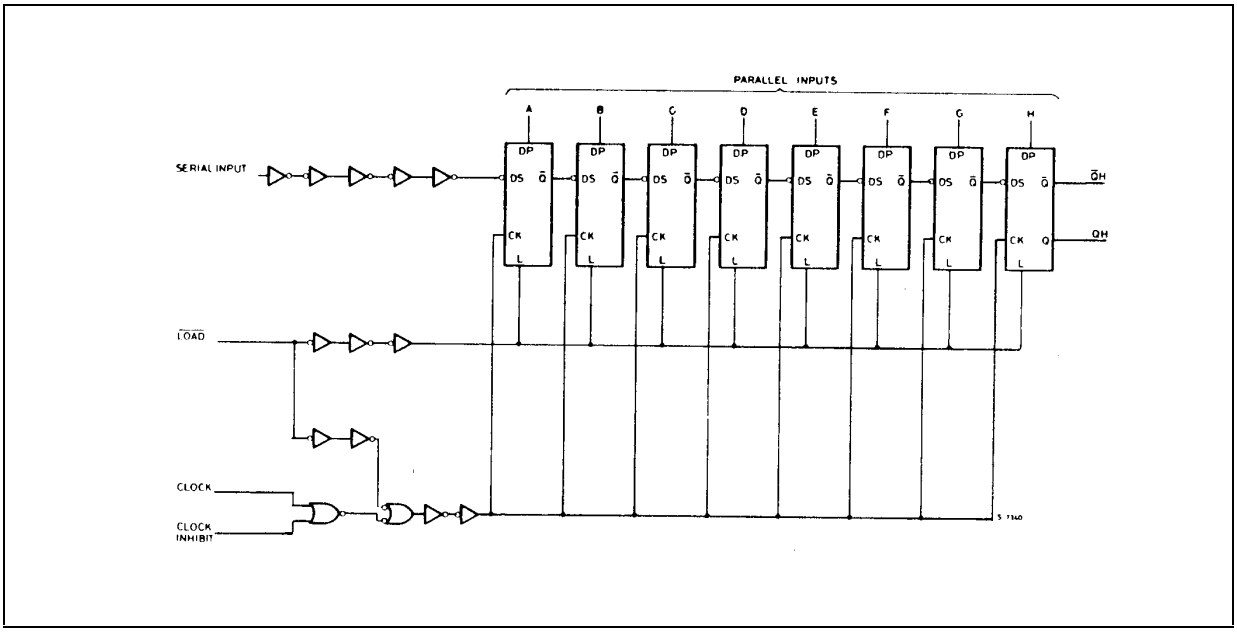
| PIN No | SYMBOL | NAME AND FUNCTION |
|---|---|---|
| 1 | SHIFT/$\overline{\text{LOAD}}$ | Data Inputs |
| 2 | $\overline{\text{QH}}$ | Complementary Output |
| 7 | QH | Serial Output |
| 9 | CLOCK | Clock Input (LOW to HIGH, Edge Triggered |
| 10 | SI | Serial Data Inputs |
| 11, 12, 13, 14, 3, 4, 5, 6 | A to H | Parallel Data Inputs |
| 15 | CLOCK INH | Clock Inhibit |
| 8 | GND | Ground (0V) |
| 16 | Vcc | Positive Supply Voltage |

## TRUTH TABLE

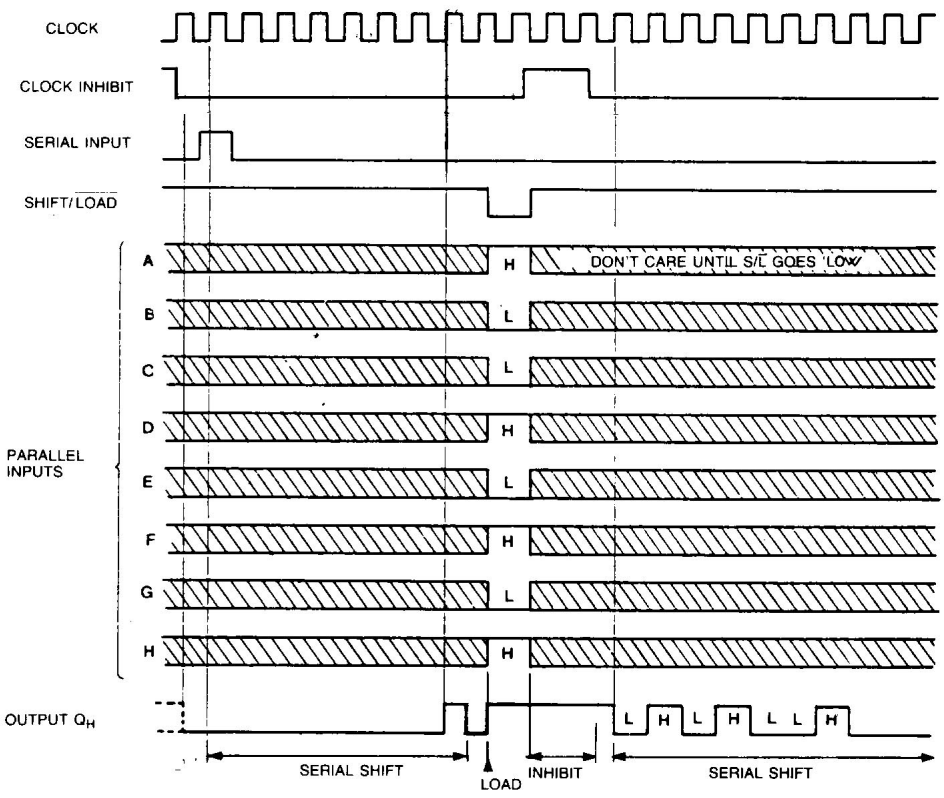
| INPUTS | | | | | INTERNAL OUTPUTS | | OUTPUTS |
|---|---|---|---|---|---|---|---|
| SHIFT / LOAD | CLOCK INH | CLOCK | SI | A.....H | QA | QB | QH |
| L | X | X | X | a.....h | a | b | h |
| H | L | ⌐ | H | X | H | QAn | QGn |
| H | L | ⌐ | L | X | L | QAn | QGn |
| H | ⌐ | L | H | X | H | QAn | QGn |
| H | ⌐ | L | L | X | L | QAn | QGn |
| H | X | H | X | X | NO CHANGE | | |
| H | H | X | X | X | NO CHANGE | | |

a.....h : The level of steady input voltage at inputs a through respectively
QAn - QGn : The level of QA - QG, respectively. before the most-recent transition of the clock

## LOGIC DIAGRAM



## 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 Current | ± 25 | mA |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | ± 50 | mA |
| $P_D$ | Power Dissipation | 500(*) | mW |
| $T_{stg}$ | Storage Temperature | -65 to +150 | °C |
| $T_L$ | Lead Temperature (10 sec) | 300 | °C |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied
(*) 500mW at 65 °C; derate to 300mW by 10mW/°C from 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 |
| $T_{op}$ | Operating Temperature | | -55 to 125 | °C |
| $t_r$, $t_f$ | Input Rise and Fall Time | $V_{CC}$ = 2.0V | 0 to 1000 | ns |
| | | $V_{CC}$ = 4.5V | 0 to 500 | ns |
| | | $V_{CC}$ = 6.0V | 0 to 400 | ns |

## DC SPECIFICATIONS

| Symbol | Parameter | Test Condition | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | 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 | $I_O$=-20 µA | 1.9 | 2.0 | | 1.9 | | 1.9 | | V |
| | | 4.5 | $I_O$=-20 µA | 4.4 | 4.5 | | 4.4 | | 4.4 | | |
| | | 6.0 | $I_O$=-20 µA | 5.9 | 6.0 | | 5.9 | | 5.9 | | |
| | | 4.5 | $I_O$=-4.0 mA | 4.18 | 4.31 | | 4.13 | | 4.10 | | |
| | | 6.0 | $I_O$=-5.2 mA | 5.68 | 5.8 | | 5.63 | | 5.60 | | |
| $V_{OL}$ | Low Level Output Voltage | 2.0 | $I_O$=20 µA | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | 4.5 | $I_O$=20 µA | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 6.0 | $I_O$=20 µA | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 4.5 | $I_O$=4.0 mA | | 0.17 | 0.26 | | 0.33 | | 0.40 | |
| | | 6.0 | $I_O$=5.2 mA | | 0.18 | 0.26 | | 0.33 | | 0.40 | |
| $I_I$ | Input Leakage Current | 6.0 | $V_I$ = $V_{CC}$ or GND | | | ± 0.1 | | ± 1 | | ± 1 | µA |
| $I_{CC}$ | Quiescent Supply Current | 6.0 | $V_I$ = $V_{CC}$ or GND | | | 4 | | 40 | | 80 | µA |

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

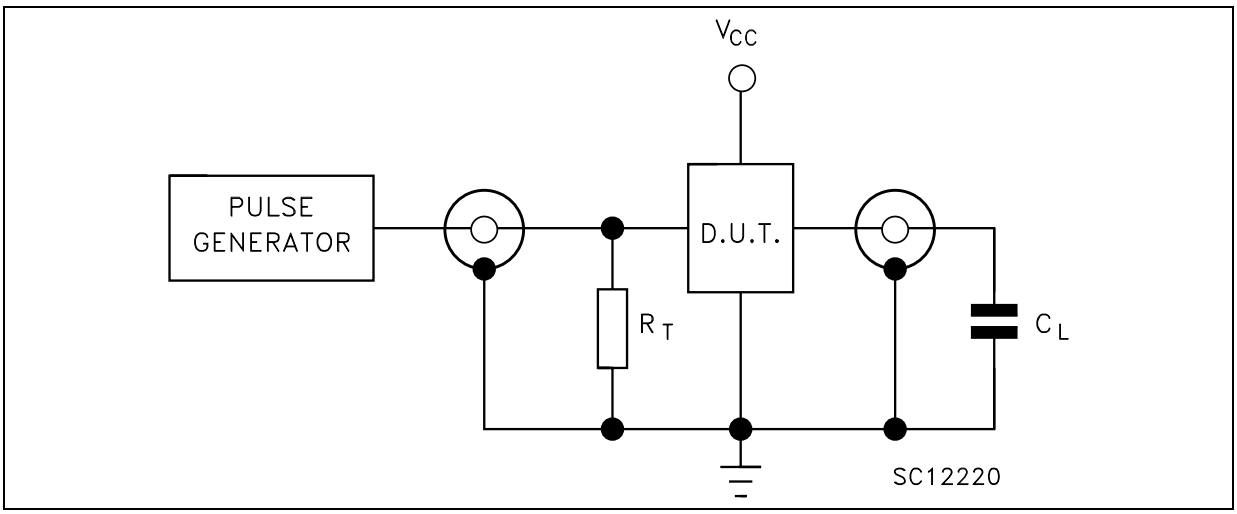
| Symbol | Parameter | Test Condition | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $t_{TLH}$ $t_{THL}$ | Output Transition Time | 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 - QH, $\overline{Q}$H) | 2.0 | | | 55 | 150 | | 190 | | 225 | ns |
| | | 4.5 | | | 18 | 30 | | 38 | | 45 | |
| | | 6.0 | | | 15 | 26 | | 33 | | 38 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time ($\overline{SHIFT/LOAD}$ - QH, $\overline{Q}$H) | 2.0 | | | 65 | 165 | | 205 | 250 | | ns |
| | | 4.5 | | | 21 | 33 | | 41 | | 50 | |
| | | 6.0 | | | 18 | 28 | | 35 | | 43 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (H - QH, $\overline{Q}$H) | 2.0 | | | 52 | 135 | | 170 | | 205 | ns |
| | | 4.5 | | | 17 | 27 | | 34 | | 41 | |
| | | 6.0 | | | 14 | 23 | | 29 | | 35 | |
| $f_{MAX}$ | Maximum Clock Frequency | 2.0 | | 7.4 | 15 | | 6.0 | | 4.8 | | MHz |
| | | 4.5 | | 37 | 60 | | 30 | | 24 | | |
| | | 6.0 | | 44 | 71 | | 35 | | 28 | | |
| $t_{W(H)}$ $t_{W(L)}$ | Minimum Pulse Width (CLOCK) | 2.0 | | | 24 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 6 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 5 | 13 | | 16 | | 19 | |
| $t_{W(L)}$ | Minimum Pulse Width ($\overline{SHIFT/LOAD}$) | 2.0 | | | 32 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 8 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 7 | 13 | | 16 | | 19 | |
| $t_s$ | Minimum Set-up Time ($\overline{PI}$-$\overline{SHIFT/LOAD}$) (SI - $\underline{CLOCK}$) ($\overline{SHIFT/LOAD}$ - CK) | 2.0 | | | 24 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 6 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 5 | 13 | | 16 | | 19 | |
| $t_h$ | Minimum Hold Time ($\overline{PI}$ - $\overline{SHIFT/LOAD}$) (SI - $\underline{CLOCK}$) ($\overline{SHIFT/LOAD}$ - CK) | 2.0 | | | | 0 | | 0 | | 0 | ns |
| | | 4.5 | | | | 0 | | 0 | | 0 | |
| | | 6.0 | | | | 0 | | 0 | | 0 | |
| $t_{REM}$ | Minimum Removal Time (CLOCK - CK INH) | 2.0 | | | 20 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 5 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 4 | 13 | | 16 | | 19 | |

**CAPACITIVE CHARACTERISTICS**

| Symbol | Parameter | Test Condition | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $C_{IN}$ | Input Capacitance | 5.0 | | | 5 | 10 | | 10 | | 10 | pF |
| $C_{PD}$ | Power Dissipation Capacitance (note 1) | 5.0 | | | 55 | | | | | | pF |

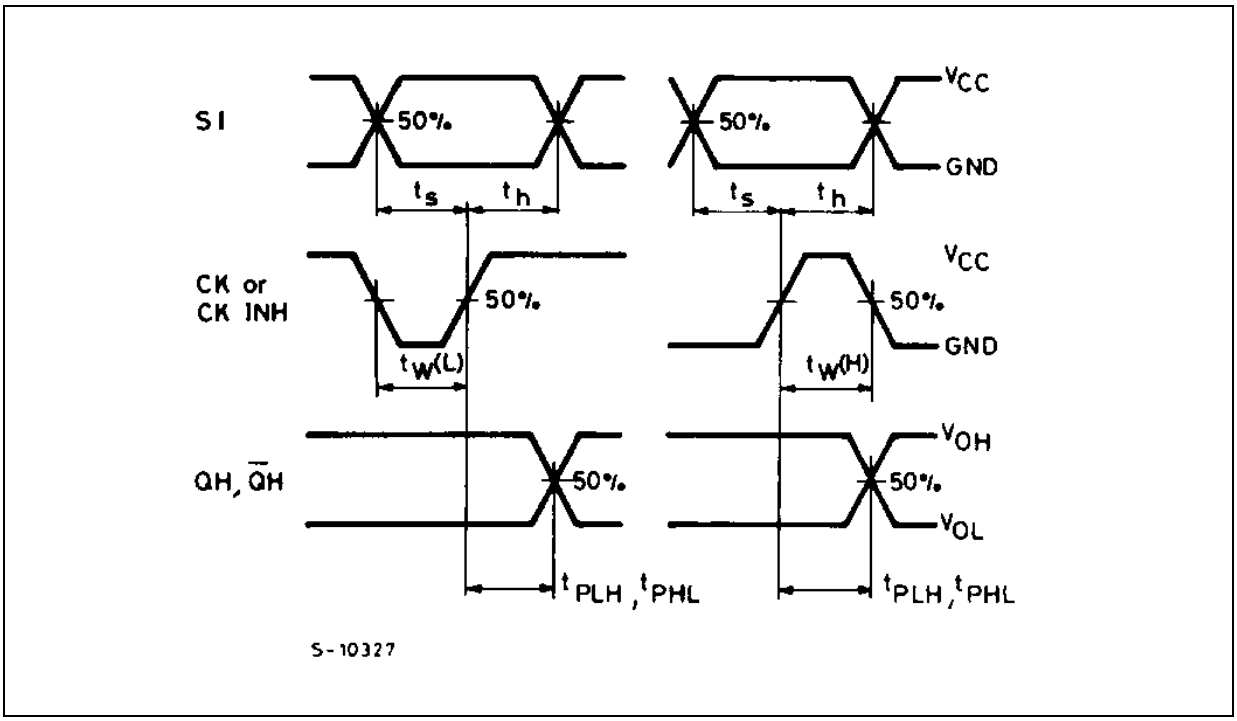
1) $C_{PD}$ is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

## TEST CIRCUIT

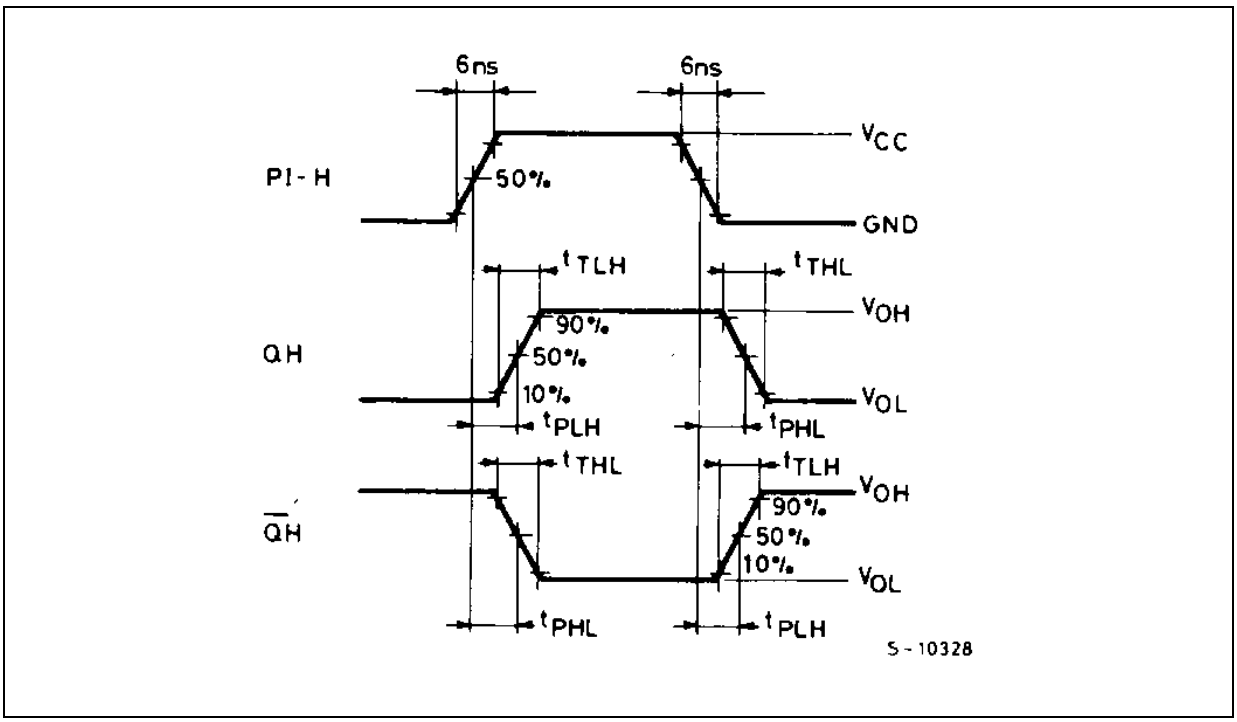



$C_L$ = 50pF or equivalent (includes jig and probe capacitance)
$R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

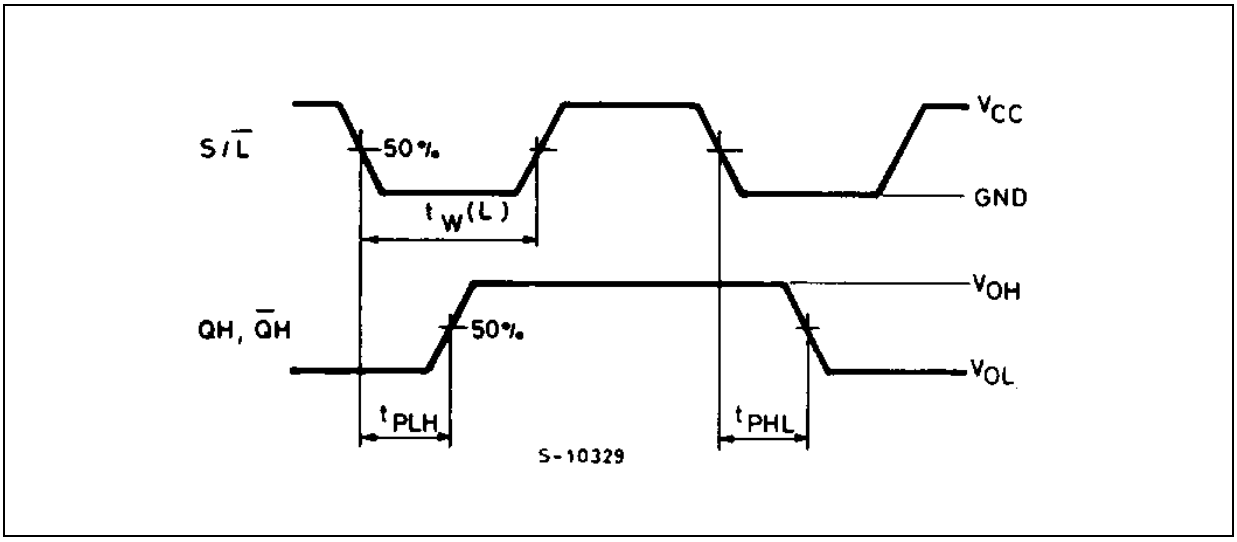
**WAVEFORM 1: SERIAL MODE PROPAGATION DELAY** (f=1MHz; 50% duty cycle)



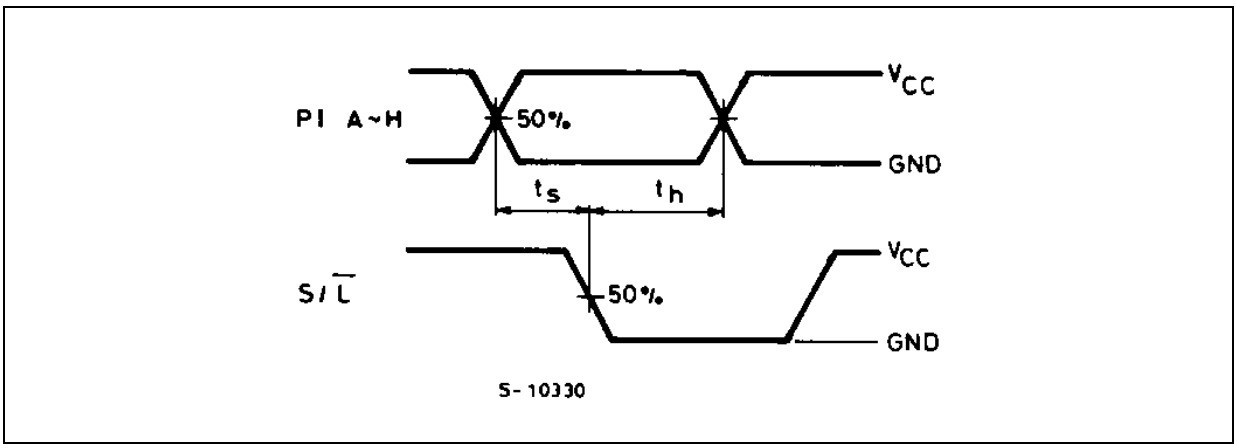
**WAVEFORM 2: PARALLEL MODE PROPAGATION DELAY** (f=1MHz; 50% duty cycle)



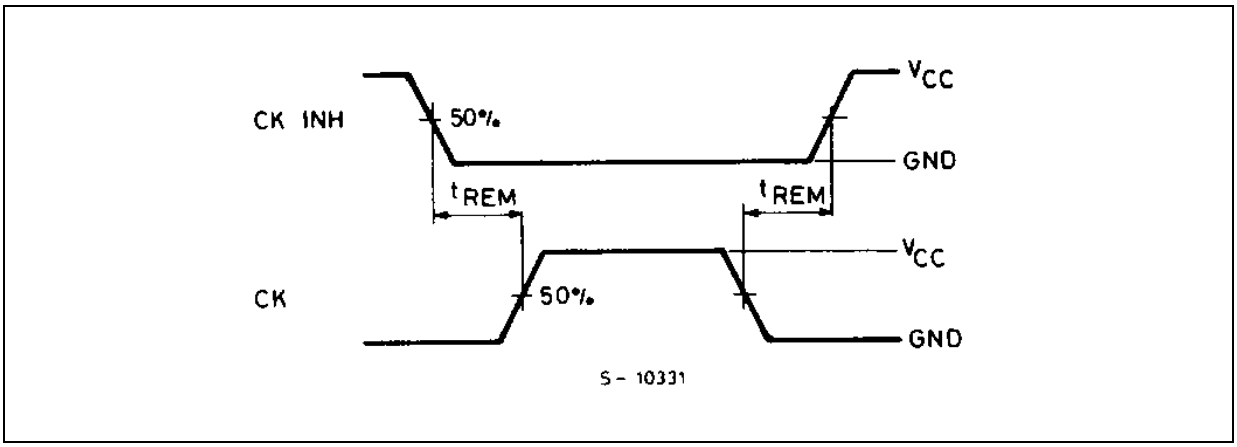

**WAVEFORM 3: MINIMUM PULSE WIDTH (S/$\overline{L}$), PROPAGATION DELAY TIMES**
(f=1MHz; 50% duty cycle)



**WAVEFORM 4: SETUP AND HOLD TIME (PI TO S/$\overline{L}$)** (f=1MHz; 50% duty cycle)

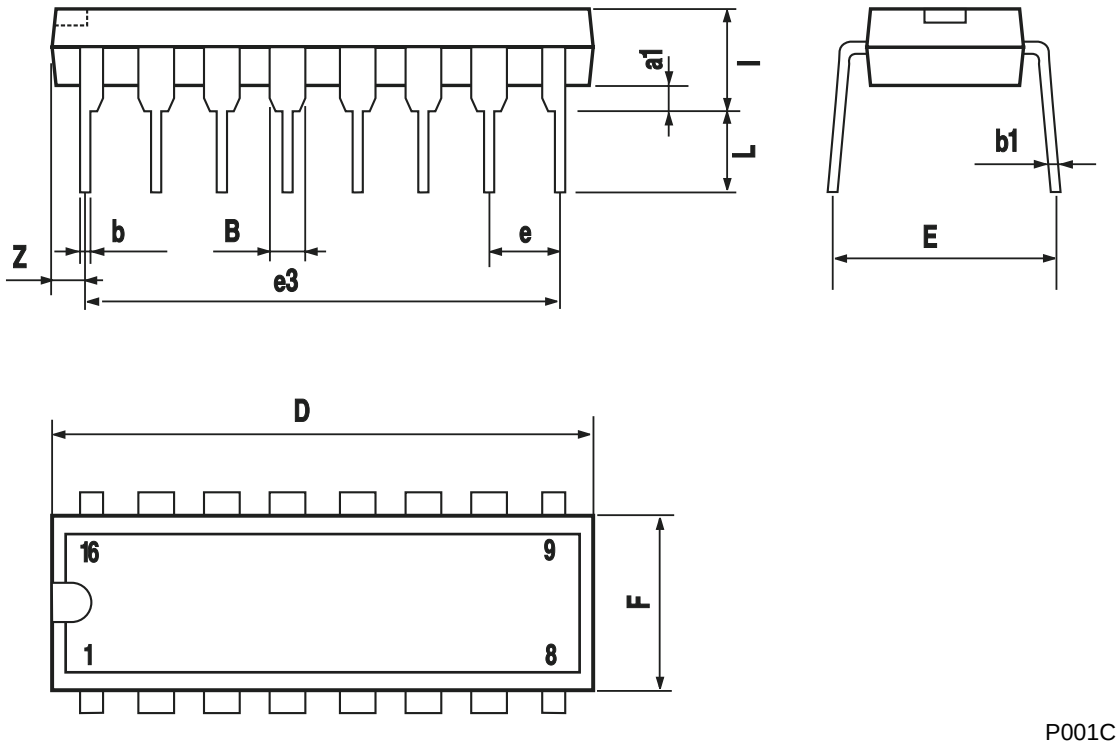



**WAVEFORM 5: MINIMUM REMOVAL TIME (CK INH TO CK)** (f=1MHz; 50% duty cycle)



## Plastic DIP-16 (0.25) MECHANICAL DATA

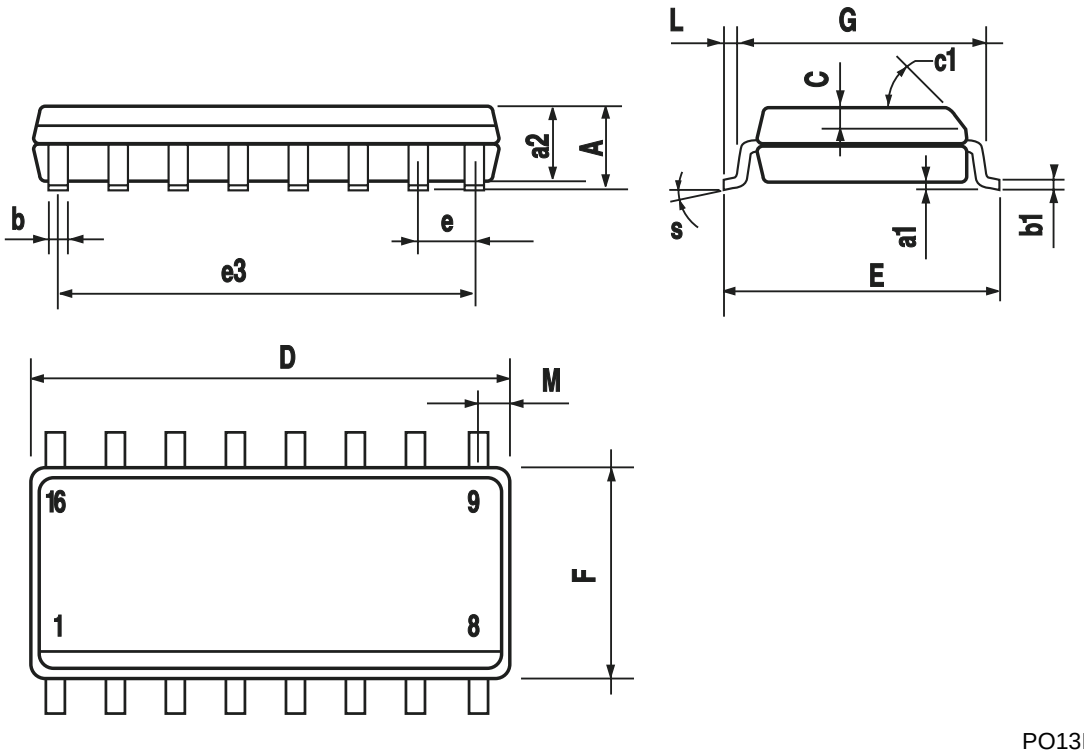
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 0.100 | |
| e3 | | 17.78 | | | 0.700 | |
| F | | | 7.1 | | | 0.280 |
| I | | | 5.1 | | | 0.201 |
| L | | 3.3 | | | 0.130 | |
| Z | | | 1.27 | | | 0.050 |




P001C

## SO-16 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.2 | 0.003 | | 0.007 |
| a2 | | | 1.65 | | | 0.064 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.019 | |
| c1 | 45° (typ.) | | | | | |
| D | 9.8 | | 10 | 0.385 | | 0.393 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 8.89 | | | 0.350 | |
| F | 3.8 | | 4.0 | 0.149 | | 0.157 |
| G | 4.6 | | 5.3 | 0.181 | | 0.208 |
| L | 0.5 | | 1.27 | 0.019 | | 0.050 |
| M | | | 0.62 | | | 0.024 |
| S | 8° (max.) | | | | | |




PO13H

## TSSOP16 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0089 |
| D | 4.9 | 5 | 5.1 | 0.193 | 0.197 | 0.201 |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.48 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |