



## M74HC166

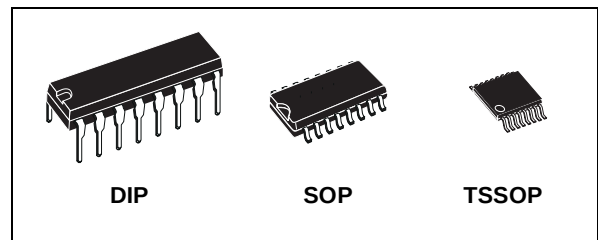
### 8 BIT PISO SHIFT REGISTER

- HIGH SPEED :  
 $f_{\text{MAX}} = 63 \text{ MHz}$  (TYP.) at  $V_{\text{CC}} = 6\text{V}$
- LOW POWER DISSIPATION:  
 $I_{\text{CC}} = 4\mu\text{A}$  (MAX.) at  $T_A = 25^\circ\text{C}$
- HIGH NOISE IMMUNITY:  
 $V_{\text{NIH}} = V_{\text{NIL}} = 28\% V_{\text{CC}}$  (MIN.)
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{\text{OH}}| = |I_{\text{OL}}| = 4\text{mA}$  (MIN)
- BALANCED PROPAGATION DELAYS:  
 $t_{\text{PLH}} \approx t_{\text{PHL}}$
- WIDE OPERATING VOLTAGE RANGE:  
 $V_{\text{CC}}$  (OPR) = 2V to 6V
- PIN AND FUNCTION COMPATIBLE WITH  
74 SERIES 166

#### DESCRIPTION

The M74HC166 is an high speed CMOS 8 BIT PISO SHIFT REGISTER fabricated with silicon gate C<sup>2</sup>MOS technology.

It consists of parallel or serial inputs and a serial-out 8 bit shift register with gated clock inputs and an overriding clear input. The parallel-in or serial-in modes are controlled by the SHIFT/LOAD input. When the SHIFT/LOAD input is held high, the serial data input is enabled and the eight flip-flops perform serial shifting with each clock pulse; when held low, the parallel data inputs are

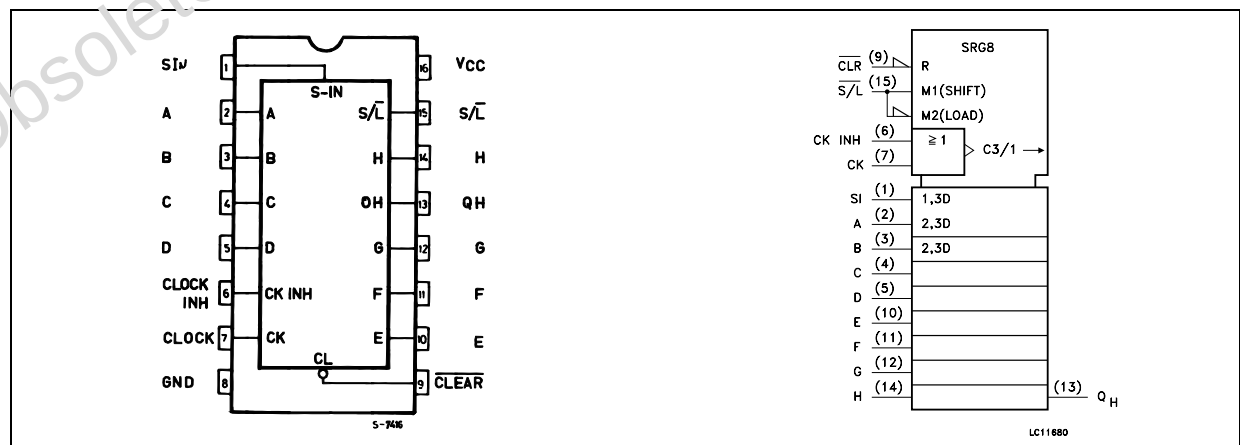


#### ORDER CODES

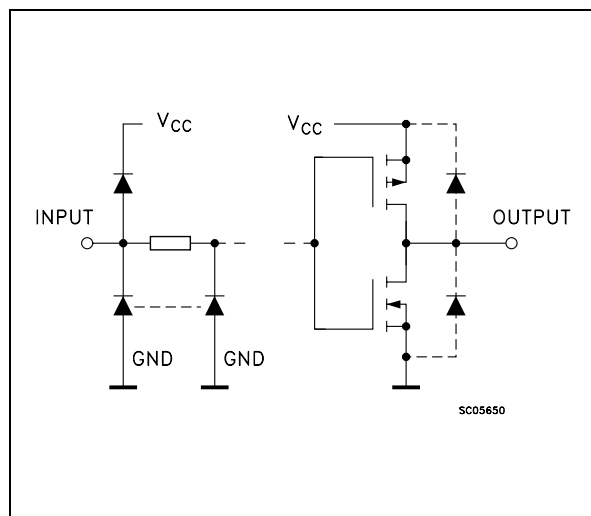
| PACKAGE | TUBE        | T & R          |
|---------|-------------|----------------|
| DIP     | M74HC166B1R |                |
| SOP     | M74HC166M1R | M74HC166RM13TR |
| TSSOP   |             | M74HC166TTR    |

enabled and synchronous loading occurs on the next clock pulse. Clocking is accomplished on the low-to-high level edge of the clock pulse. The CLOCK INHIBIT input should be changed to the high only while the clock input is held high. A direct clear input overrides all other inputs, including the clock, and sets all flip-flops to zero. Functional details are shown in the truth table and the timing chart. 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                          | SI                              | Serial Data Inputs                           |
| 2, 3, 4, 5, 10, 11, 12, 14 | A to H                          | Parallel Data Inputs                         |
| 6                          | CLOCK INH                       | Clock Enable Input (Active Low)              |
| 7                          | CLOCK                           | Clock Input (LOW to HIGH, Edge Triggered)    |
| 9                          | $\overline{\text{CLEAR}}$       | Asynchronous Master Reset Input (Active Low) |
| 13                         | $Q_H$                           | Serial Output from the Last Stage            |
| 15                         | SHIFT/ $\overline{\text{LOAD}}$ | Parallel Enable Input (Active Low)           |
| 8                          | GND                             | Ground (0V)                                  |
| 16                         | Vcc                             | Positive Supply Voltage                      |

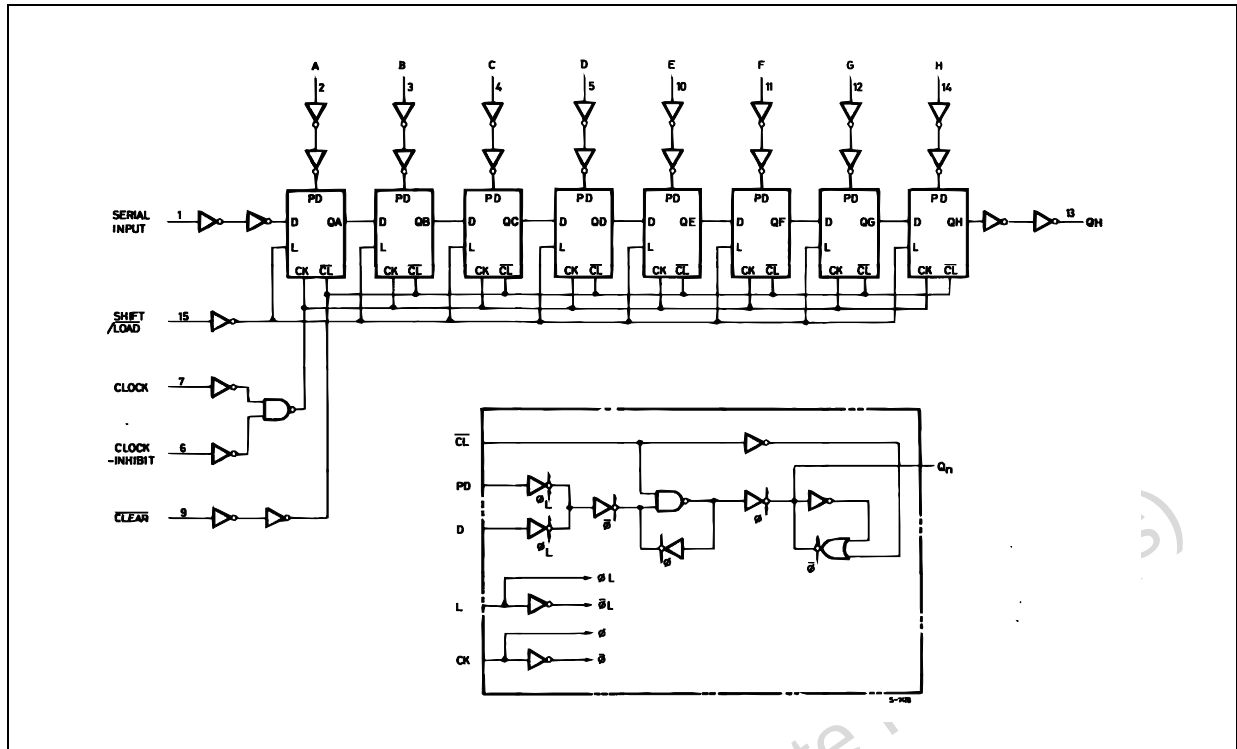
## TRUTH TABLE

| INPUTS                    |                |              |       |           |                     | INTERNAL OUTPUTS |     | OUTPUTS |
|---------------------------|----------------|--------------|-------|-----------|---------------------|------------------|-----|---------|
| $\overline{\text{CLEAR}}$ | SHIFT/<br>LOAD | CLOCK<br>INH | CLOCK | SERIAL IN | PARALLEL<br>A.....H | QA               | QB  | QH      |
| L                         | X              | X            | X     | X         | X                   | L                | L   | L       |
| L                         | X              | X            |       | X         | X                   | NO CHANGE        |     |         |
| H                         | L              | L            |       | X         | a.....h             | a                | b   | h       |
| H                         | H              | L            |       | H         | X                   | H                | QAn | QGn     |
| H                         | H              | L            |       | L         | X                   | L                | QAn | QGn     |
| H                         | X              | H            | X     | X         | X                   | NO CHANGE        |     |         |

X : Don't Care

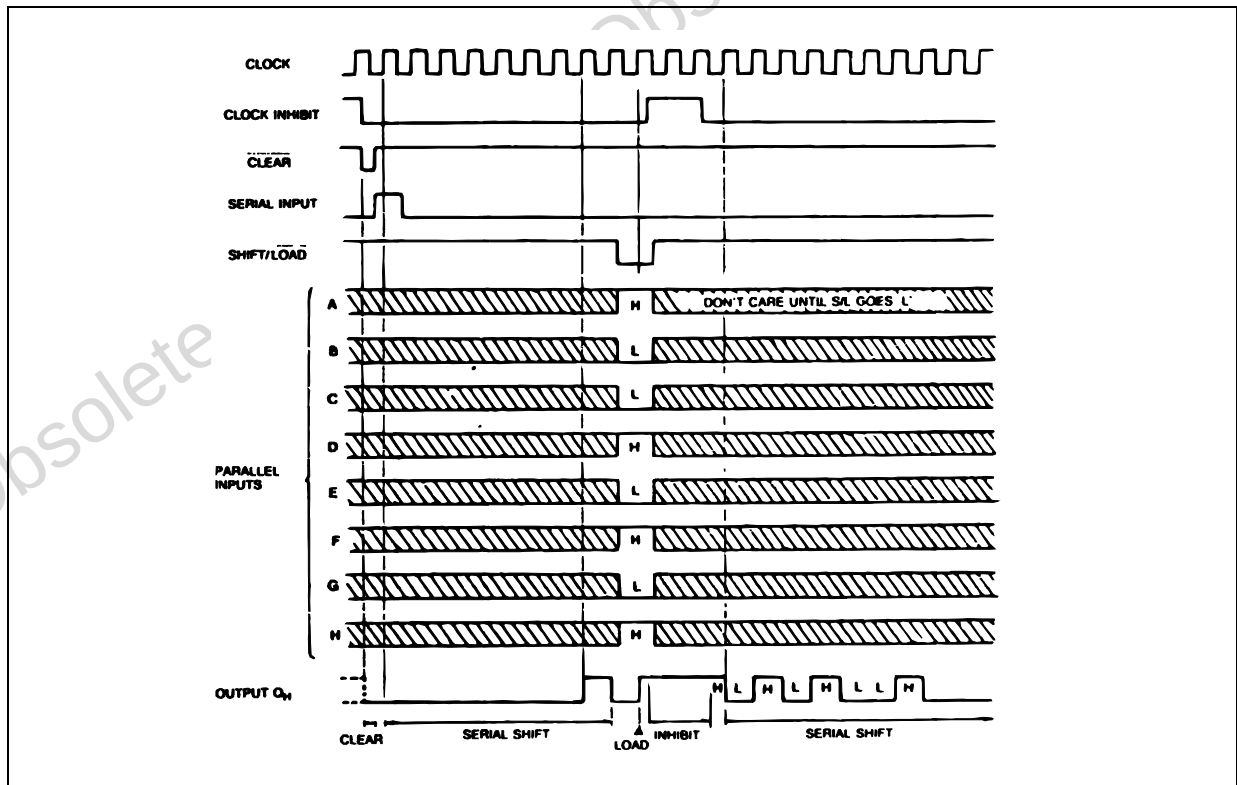
a.....h : The level of steady input voltage at inputs a through H respectively

## LOGIC DIAGRAM



This logic diagram has not be used to estimate propagation delays

## 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        | $\pm 20$               | mA   |
| $I_{OK}$              | DC Output Diode Current       | $\pm 20$               | mA   |
| $I_O$                 | DC Output Current             | $\pm 25$               | mA   |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | $\pm 50$               | 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 <sub>CC</sub>                 | Supply Voltage           |                        | 2 to 6               | V    |
| V <sub>I</sub>                  | Input Voltage            |                        | 0 to V <sub>CC</sub> | V    |
| V <sub>O</sub>                  | Output Voltage           |                        | 0 to V <sub>CC</sub> | V    |
| T <sub>op</sub>                 | Operating Temperature    |                        | -55 to 125           | °C   |
| t <sub>r</sub> , t <sub>f</sub> | Input Rise and Fall Time | V <sub>CC</sub> = 2.0V | 0 to 1000            | ns   |
|                                 |                          | V <sub>CC</sub> = 4.5V | 0 to 500             | ns   |
|                                 |                          | V <sub>CC</sub> = 6.0V | 0 to 400             | ns   |

## DC SPECIFICATIONS

| Symbol          | Parameter                 | Test Condition         |                                         | Value                 |      |       |             |      |              | Unit |      |  |
|-----------------|---------------------------|------------------------|-----------------------------------------|-----------------------|------|-------|-------------|------|--------------|------|------|--|
|                 |                           | V <sub>CC</sub><br>(V) |                                         | T <sub>A</sub> = 25°C |      |       | -40 to 85°C |      | -55 to 125°C |      |      |  |
|                 |                           |                        |                                         | Min.                  | Typ. | Max.  | Min.        | Max. | Min.         |      | Max. |  |
| V <sub>IH</sub> | 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 <sub>IL</sub> | 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 <sub>OH</sub> | High Level Output Voltage | 2.0                    | I <sub>O</sub> =-20 μA                  | 1.9                   | 2.0  |       | 1.9         |      | 1.9          |      | V    |  |
|                 |                           | 4.5                    | I <sub>O</sub> =-20 μA                  | 4.4                   | 4.5  |       | 4.4         |      | 4.4          |      |      |  |
|                 |                           | 6.0                    | I <sub>O</sub> =-20 μA                  | 5.9                   | 6.0  |       | 5.9         |      | 5.9          |      |      |  |
|                 |                           | 4.5                    | I <sub>O</sub> =-4.0 mA                 | 4.18                  | 4.31 |       | 4.13        |      | 4.10         |      |      |  |
|                 |                           | 6.0                    | I <sub>O</sub> =-5.2 mA                 | 5.68                  | 5.8  |       | 5.63        |      | 5.60         |      |      |  |
| V <sub>OL</sub> | Low Level Output Voltage  | 2.0                    | I <sub>O</sub> =20 μA                   |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  | V    |  |
|                 |                           | 4.5                    | I <sub>O</sub> =20 μA                   |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  |      |  |
|                 |                           | 6.0                    | I <sub>O</sub> =20 μA                   |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  |      |  |
|                 |                           | 4.5                    | I <sub>O</sub> =4.0 mA                  |                       | 0.17 | 0.26  |             | 0.33 |              | 0.40 |      |  |
|                 |                           | 6.0                    | I <sub>O</sub> =5.2 mA                  |                       | 0.18 | 0.26  |             | 0.33 |              | 0.40 |      |  |
| I <sub>I</sub>  | Input Leakage Current     | 6.0                    | V <sub>I</sub> = V <sub>CC</sub> or GND |                       |      | ± 0.1 |             | ± 1  |              | ± 1  | μA   |  |
| I <sub>CC</sub> | Quiescent Supply Current  | 6.0                    | V <sub>I</sub> = V <sub>CC</sub> or GND |                       |      | 4     |             | 40   |              | 80   | μA   |  |

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

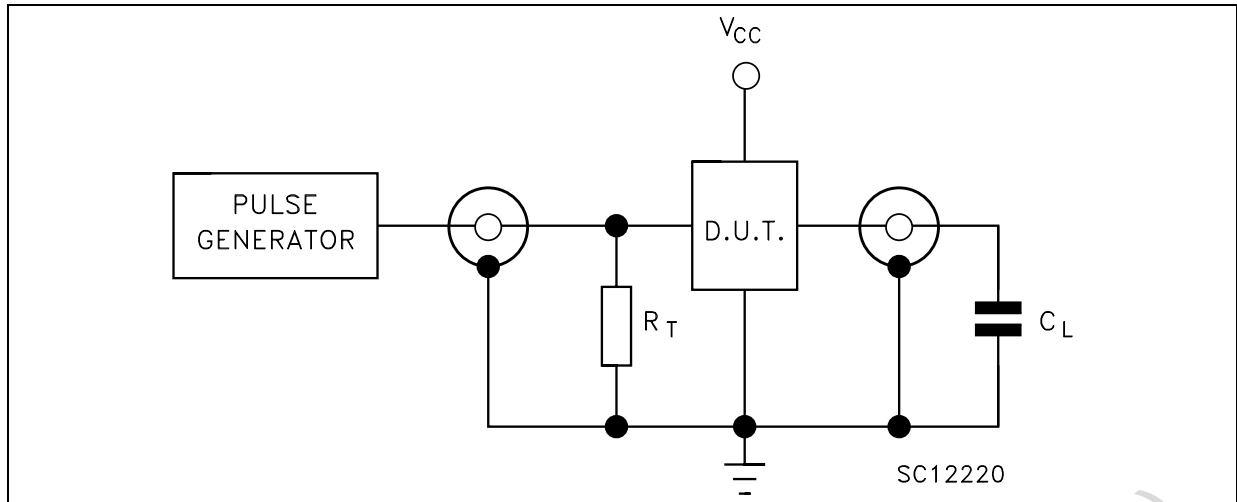
| Symbol                                 | Parameter                                                   | Test Condition         |  | Value                 |      |      |             |      |              | Unit |      |
|----------------------------------------|-------------------------------------------------------------|------------------------|--|-----------------------|------|------|-------------|------|--------------|------|------|
|                                        |                                                             | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                                        |                                                             |                        |  | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| t <sub>TLH</sub> t <sub>THL</sub>      | Output Transition Time                                      | 2.0                    |  |                       | 30   | 75   |             | 95   |              | 110  | ns   |
|                                        |                                                             | 4.5                    |  |                       | 8    | 15   |             | 19   |              | 22   |      |
|                                        |                                                             | 6.0                    |  |                       | 7    | 13   |             | 16   |              | 19   |      |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time<br>(CLOCK - QH)                      | 2.0                    |  |                       | 70   | 150  |             | 190  |              | 225  | ns   |
|                                        |                                                             | 4.5                    |  |                       | 20   | 30   |             | 38   |              | 45   |      |
|                                        |                                                             | 6.0                    |  |                       | 16   | 26   |             | 32   |              | 38   |      |
| t <sub>PHL</sub>                       | Propagation Delay Time<br>( $\overline{\text{CLEAR}}$ - QH) | 2.0                    |  |                       | 60   | 135  |             | 170  |              | 205  | ns   |
|                                        |                                                             | 4.5                    |  |                       | 18   | 27   |             | 34   |              | 41   |      |
|                                        |                                                             | 6.0                    |  |                       | 14   | 23   |             | 29   |              | 35   |      |
| f <sub>MAX</sub>                       | Maximum Clock Frequency                                     | 2.0                    |  | 6.2                   | 14   |      | 5.0         |      | 4.2          |      | MHz  |
|                                        |                                                             | 4.5                    |  | 31                    | 50   |      | 25          |      | 21           |      |      |
|                                        |                                                             | 6.0                    |  | 37                    | 63   |      | 30          |      | 25           |      |      |
| t <sub>W(H)</sub><br>t <sub>W(L)</sub> | Minimum Pulse Width (CLOCK)                                 | 2.0                    |  |                       | 28   | 75   |             | 95   |              | 110  | ns   |
|                                        |                                                             | 4.5                    |  |                       | 6    | 15   |             | 19   |              | 22   |      |
|                                        |                                                             | 6.0                    |  |                       | 5    | 13   |             | 16   |              | 19   |      |
| t <sub>W(L)</sub>                      | Minimum Pulse Width (CLEAR)                                 | 2.0                    |  |                       | 28   | 75   |             | 95   |              | 110  | ns   |
|                                        |                                                             | 4.5                    |  |                       | 6    | 15   |             | 19   |              | 22   |      |
|                                        |                                                             | 6.0                    |  |                       | 5    | 13   |             | 16   |              | 19   |      |
| t <sub>s</sub>                         | Minimum Set-up Time (SI, PI)                                | 2.0                    |  |                       | 20   | 75   |             | 95   |              | 110  | ns   |
|                                        |                                                             | 4.5                    |  |                       | 4    | 15   |             | 19   |              | 22   |      |
|                                        |                                                             | 6.0                    |  |                       | 3    | 13   |             | 16   |              | 19   |      |
| t <sub>s</sub>                         | Minimum Set-up Time (SHIFT/LOAD)                            | 2.0                    |  |                       | 25   | 75   |             | 95   |              | 110  | ns   |
|                                        |                                                             | 4.5                    |  |                       | 5    | 15   |             | 19   |              | 22   |      |
|                                        |                                                             | 6.0                    |  |                       | 3    | 13   |             | 16   |              | 19   |      |
| t <sub>h</sub>                         | Minimum Hold Time                                           | 2.0                    |  |                       |      | 0    |             | 0    |              | 0    | ns   |
|                                        |                                                             | 4.5                    |  |                       |      | 0    |             | 0    |              | 0    |      |
|                                        |                                                             | 6.0                    |  |                       |      | 0    |             | 0    |              | 0    |      |
| t <sub>REM</sub>                       | Minimum Removal Time                                        | 2.0                    |  |                       | 12   | 50   |             | 65   |              | 75   | ns   |
|                                        |                                                             | 4.5                    |  |                       | 3    | 10   |             | 13   |              | 15   |      |
|                                        |                                                             | 6.0                    |  |                       | 3    | 9    |             | 11   |              | 13   |      |

**CAPACITIVE CHARACTERISTICS**

| Symbol          | Parameter                              | Test Condition         |  | Value                 |      |      |             |      |              | Unit |      |
|-----------------|----------------------------------------|------------------------|--|-----------------------|------|------|-------------|------|--------------|------|------|
|                 |                                        | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                 |                                        |                        |  | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| C <sub>IN</sub> | Input Capacitance                      | 5.0                    |  |                       | 5    | 10   |             | 10   |              | 10   | pF   |
| C <sub>PD</sub> | Power Dissipation Capacitance (note 1) | 5.0                    |  |                       | 60   |      |             |      |              |      | pF   |

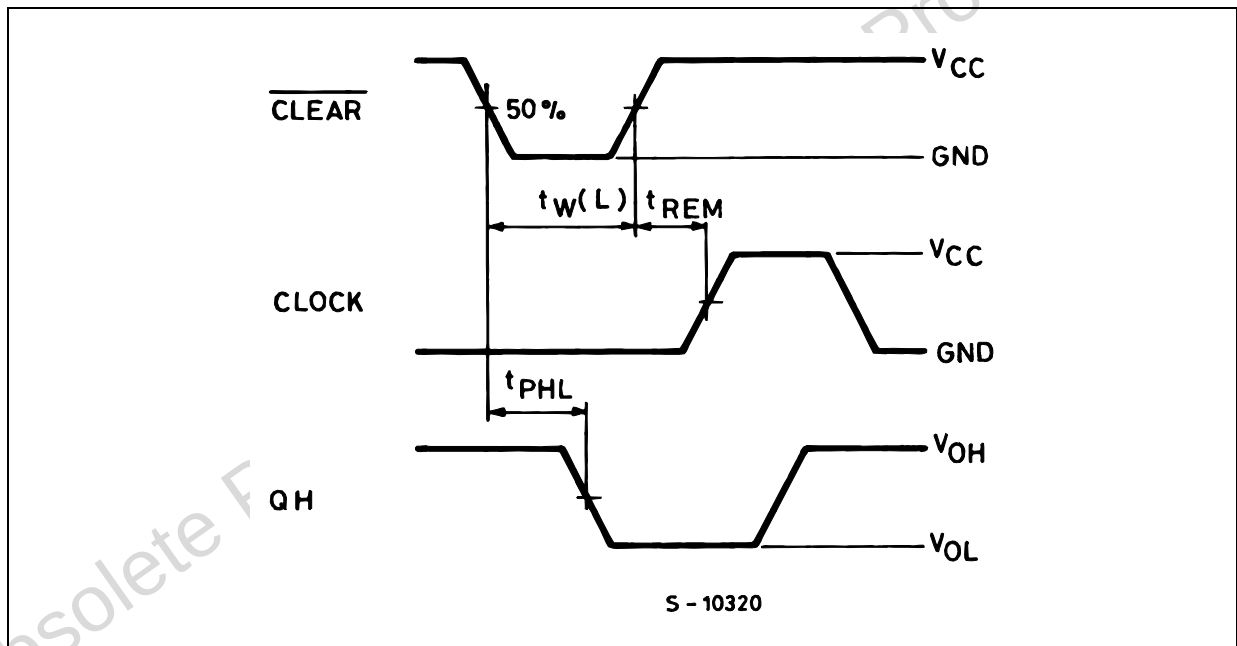
1)  $C_{PD}$  is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} +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

## TEST CIRCUIT

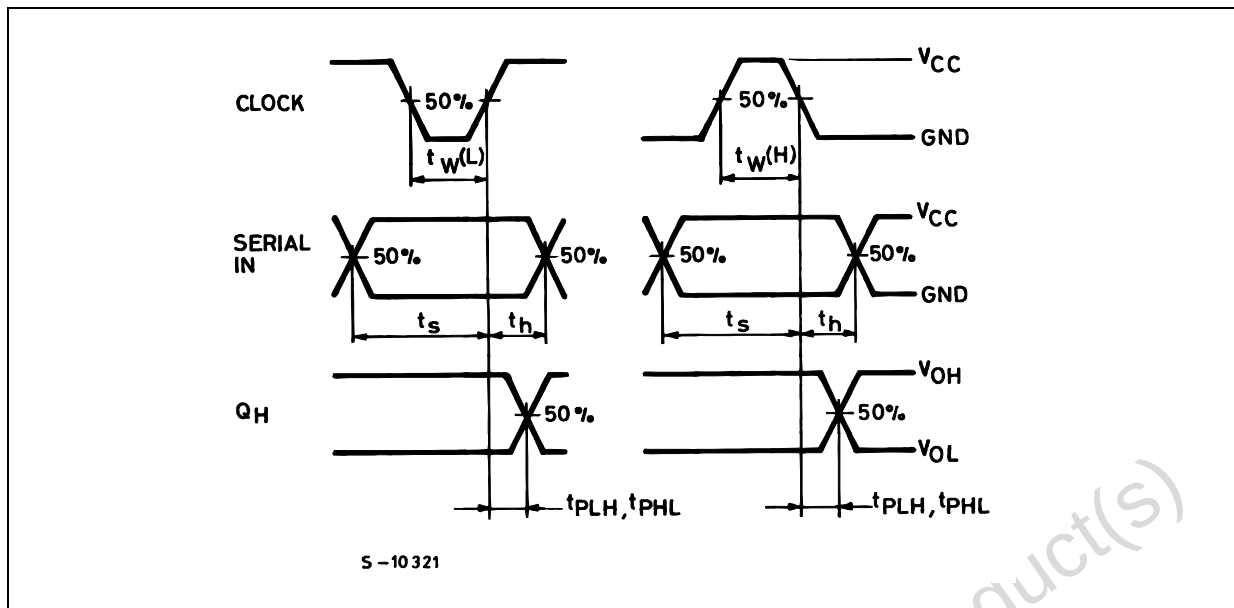


$C_L = 50\text{pF}$  or equivalent (includes jig and probe capacitance)  
 $R_T = Z_{OUT}$  of pulse generator (typically  $50\Omega$ )

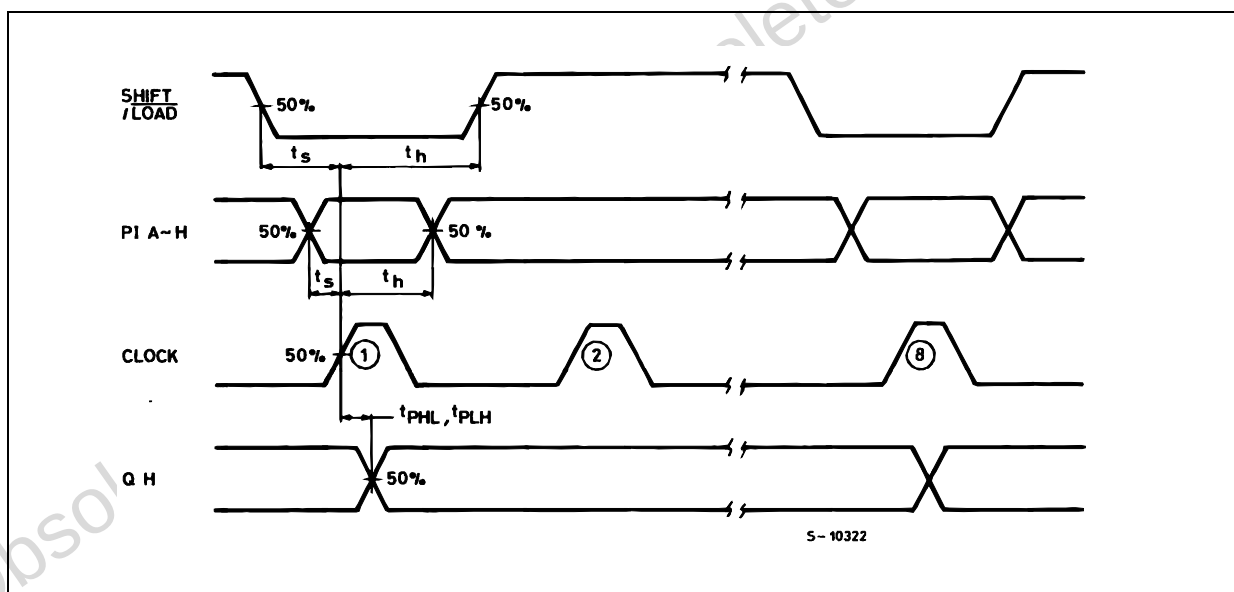
**WAVEFORM 1 : MINIMUM PULSE WIDTH (CLEAR), REMOVAL TIME (CLEAR TO CLOCK)**  
 ( $f=1\text{MHz}$ ; 50% duty cycle)



**WAVEFORM 2 : PROPAGATION DELAY TIME, MINIMUM PULSE WIDTH (CLOCK), SETUP AND HOLD TIME (SI to CLOCK) (f=1MHz; 50% duty cycle)**

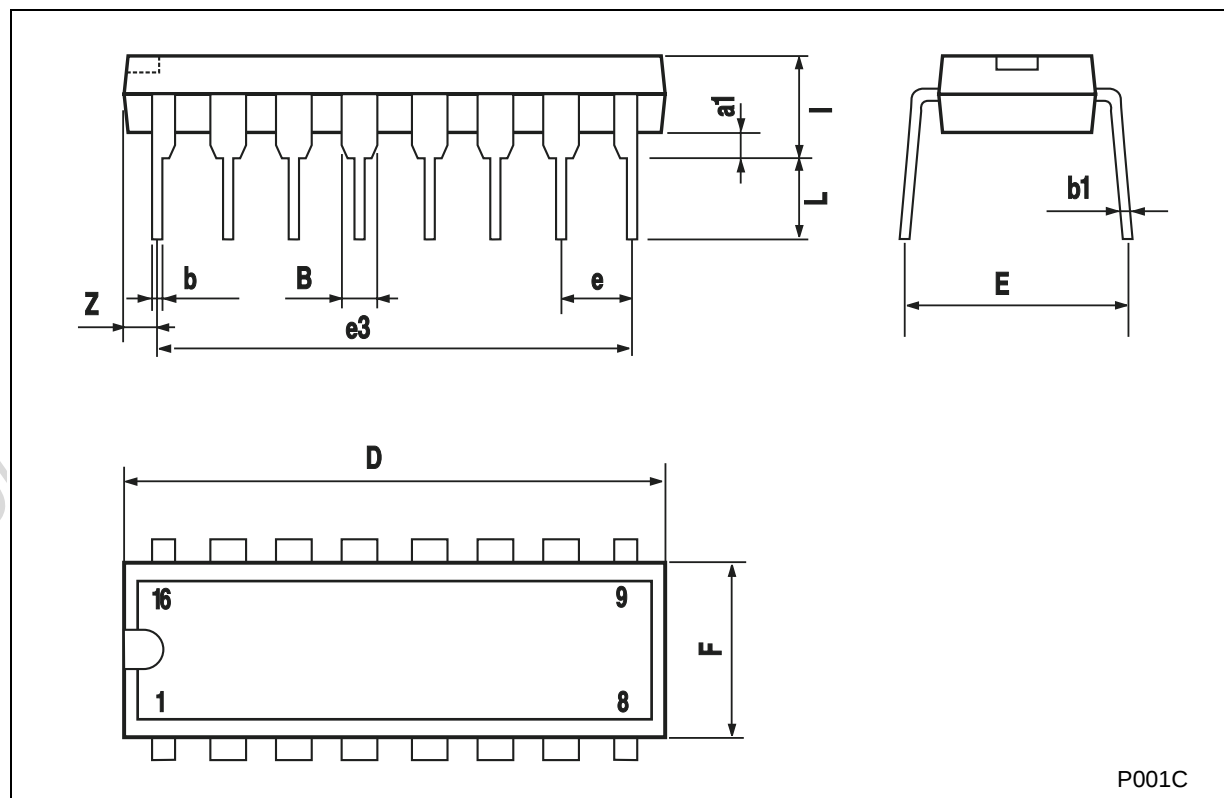


**WAVEFORM 3 : PROPAGATION DELAY TIME, SETUP AND HOLD TIME (PI,  $\overline{S/L}$  to CLOCK) (f=1MHz; 50% duty cycle)**



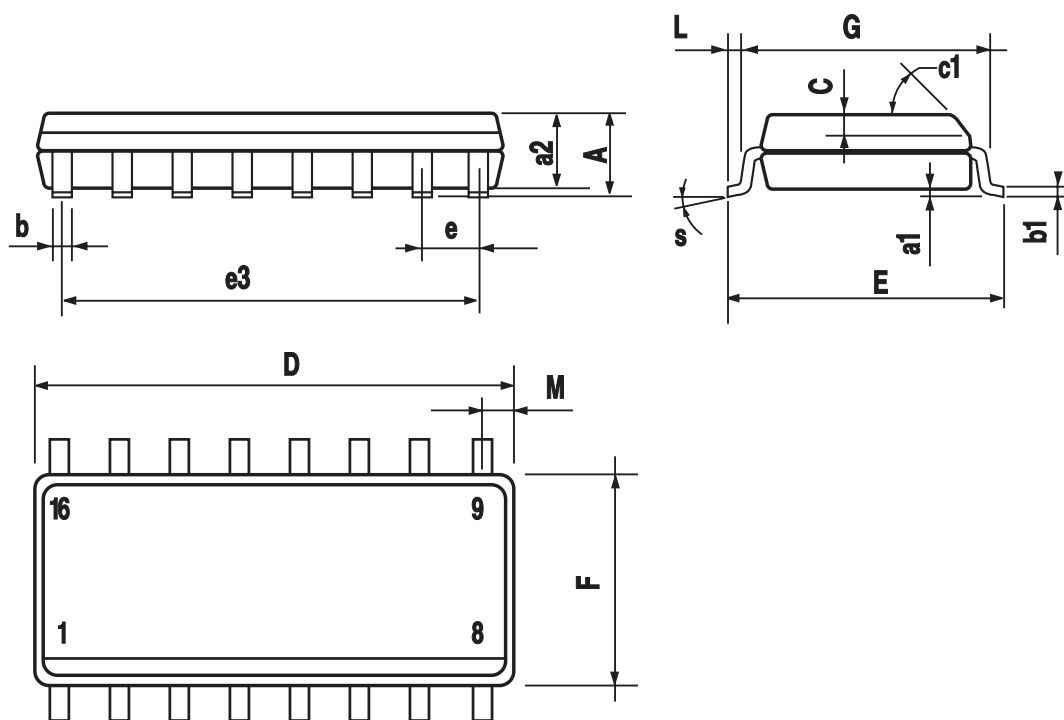
### Plastic DIP-16 (0.25) MECHANICAL DATA

| 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 |



## SO-16 MECHANICAL DATA

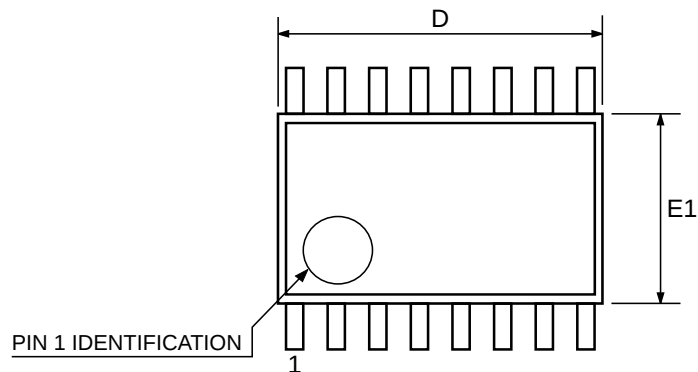
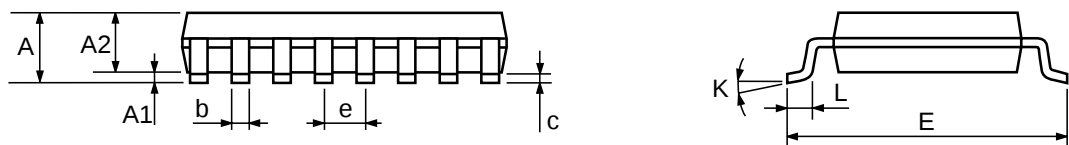
| DIM. | mm.        |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.003 |       | 0.007 |
| 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  |



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