

## DUAL J-K FLIP FLOP WITH PRESET AND CLEAR

- HIGH SPEED :  
 $f_{\text{MAX}} = 67\text{MHz}$  (TYP.) at  $V_{\text{CC}} = 6\text{V}$
- LOW POWER DISSIPATION:  
 $I_{\text{CC}} = 2\mu\text{A}$  (MAX.) at  $T_{\text{A}} = 25^{\circ}\text{C}$
- 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 109



### ORDER CODES

| PACKAGE | TUBE        | T & R          |
|---------|-------------|----------------|
| DIP     | M74HC109B1R |                |
| SOP     | M74HC109M1R | M74HC109RM13TR |
| TSSOP   |             | M74HC109TTR    |

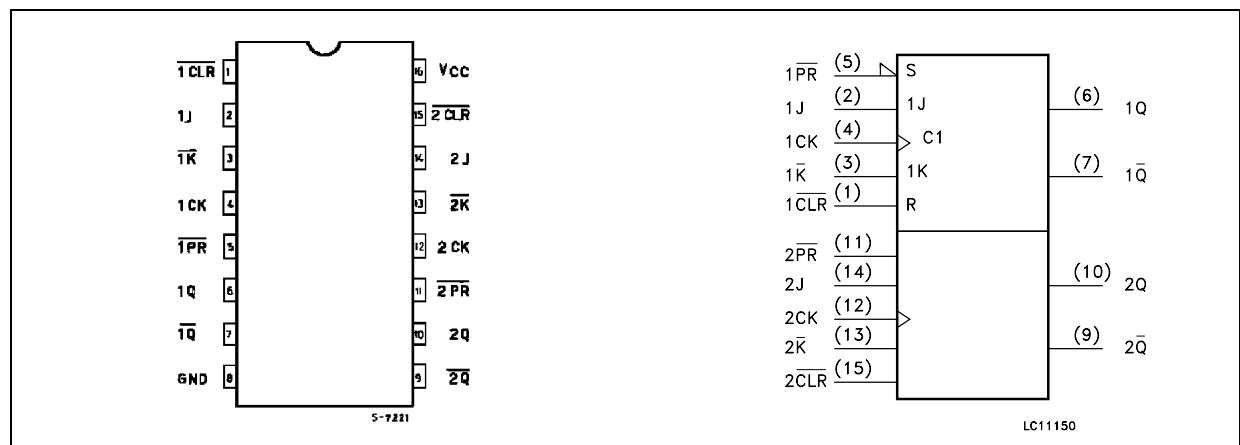
### DESCRIPTION

The M74HC109 is an high speed CMOS DUAL J-K FLIP FLOP WITH PRESET AND CLEAR fabricated with silicon gate  $\text{C}^2\text{MOS}$  technology. In accordance with the logic level on the J and  $\bar{K}$  input this device changes state on positive going transition of the clock pulse. CLEAR and PRESET

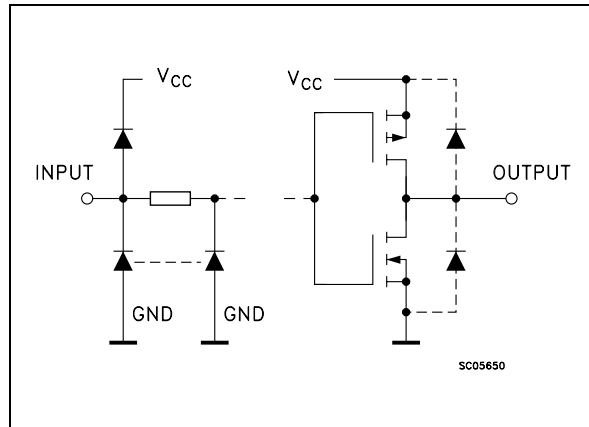
are independent of the clock and are accomplished by a logic low on the corresponding input.

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

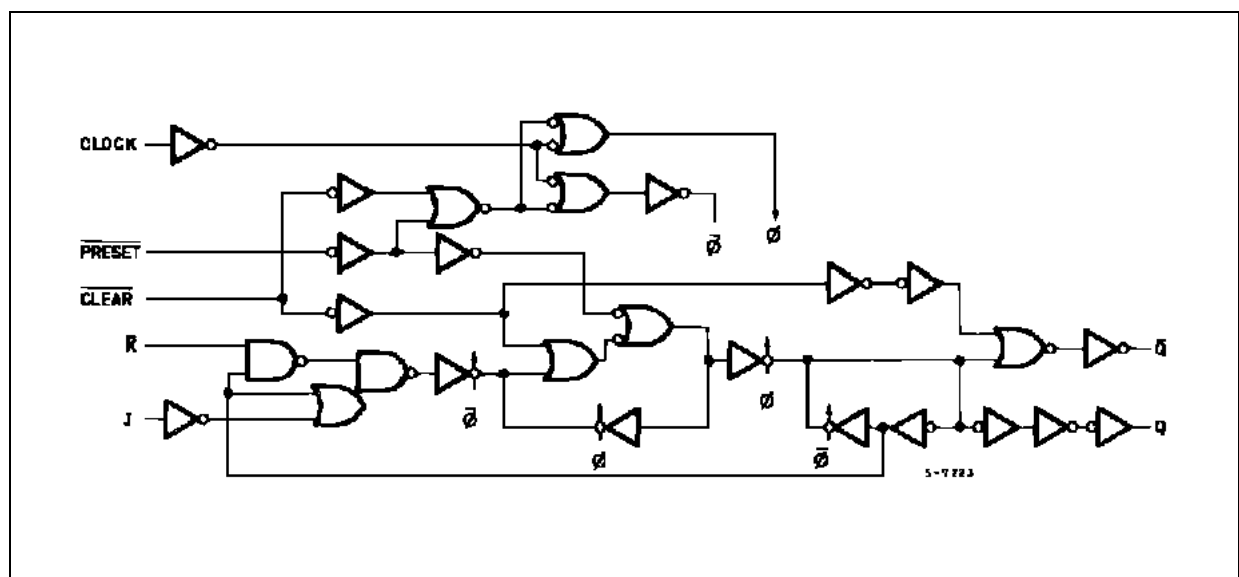
| PIN No       | SYMBOL                             | NAME AND FUNCTION                          |
|--------------|------------------------------------|--------------------------------------------|
| 1,15         | $\overline{1CLR}, \overline{2CLR}$ | Asynchronous Reset Direct Input            |
| 2, 14, 3, 13 | 1J, 2J, 1K, 2K                     | Synchronous Inputs; Flip-Flops 1 and 2     |
| 4, 12        | 1CK, 2CK                           | Clock Input                                |
| 5, 11        | $\overline{1PR}, \overline{2PR}$   | Asynchronous Set Direct Input (Active Low) |
| 6, 10        | 1Q, 2Q                             | True Flip-Flop Outputs                     |
| 7, 9         | $\overline{1Q}, \overline{2Q}$     | Complement Flip-Flop Outputs               |
| 8            | GND                                | Ground (0V)                                |
| 16           | Vcc                                | Positive Supply Voltage                    |

## TRUTH TABLE

| INPUTS           |                 |   |                |    | OUTPUTS         |                 | FUNCTION  |
|------------------|-----------------|---|----------------|----|-----------------|-----------------|-----------|
| $\overline{CLR}$ | $\overline{PR}$ | J | $\overline{K}$ | CK | Q               | $\overline{Q}$  |           |
| L                | H               | X | X              | X  | L               | H               | CLEAR     |
| H                | L               | X | X              | X  | H               | L               | PRESET    |
| L                | L               | X | X              | X  | H               | H               | ----      |
| H                | H               | L | H              |    | Qn              | $\overline{Qn}$ | NO CHANGE |
| H                | H               | L | L              |    | L               | H               | ----      |
| H                | H               | H | H              |    | H               | L               | ----      |
| H                | H               | H | L              |    | $\overline{Qn}$ | Qn              | TOGGLE    |
| H                | H               | X | X              |    | Qn              | $\overline{Qn}$ | NO CHANGE |

X : Don't Care

## LOGIC DIAGRAM



This logic diagram has not be used to estimate propagation delays

**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 |                       |      | 2     |             | 20   |              | 40   | 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 (CK - Q, Q)      | 2.0                    |  |                       | 50   | 150  |             | 190  |              | 225  | ns   |
|                                        |                                         | 4.5                    |  |                       | 16   | 30   |             | 38   |              | 45   |      |
|                                        |                                         | 6.0                    |  |                       | 13   | 26   |             | 32   |              | 38   |      |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time (CLR, PR - Q, Q) | 2.0                    |  |                       | 50   | 150  |             | 190  |              | 225  | ns   |
|                                        |                                         | 4.5                    |  |                       | 16   | 30   |             | 38   |              | 45   |      |
|                                        |                                         | 6.0                    |  |                       | 13   | 26   |             | 32   |              | 38   |      |
| f <sub>MAX</sub>                       | Maximum Clock Frequency                 | 2.0                    |  | 6.2                   | 17   |      | 5           |      | 4.2          |      | MHz  |
|                                        |                                         | 4.5                    |  | 31                    | 59   |      | 25          |      | 21           |      |      |
|                                        |                                         | 6.0                    |  | 37                    | 67   |      | 30          |      | 25           |      |      |
| t <sub>W(H)</sub><br>t <sub>W(L)</sub> | Minimum Pulse Width (CK)                | 2.0                    |  |                       | 15   | 75   |             | 95   |              | 110  | ns   |
|                                        |                                         | 4.5                    |  |                       | 6    | 15   |             | 19   |              | 22   |      |
|                                        |                                         | 6.0                    |  |                       | 6    | 13   |             | 16   |              | 19   |      |
| t <sub>W(L)</sub>                      | Minimum Pulse Width (CLR, PR)           | 2.0                    |  |                       | 15   | 75   |             | 95   |              | 110  | ns   |
|                                        |                                         | 4.5                    |  |                       | 6    | 15   |             | 19   |              | 22   |      |
|                                        |                                         | 6.0                    |  |                       | 6    | 13   |             | 16   |              | 19   |      |
| t <sub>s</sub>                         | Minimum Set-Up Time                     | 2.0                    |  |                       | 17   | 75   |             | 95   |              | 110  | ns   |
|                                        |                                         | 4.5                    |  |                       | 5    | 15   |             | 19   |              | 22   |      |
|                                        |                                         | 6.0                    |  |                       | 4    | 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 (CLR, PR)          | 2.0                    |  |                       | 13   | 50   |             | 65   |              | 75   | ns   |
|                                        |                                         | 4.5                    |  |                       | 4    | 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                    |  |                       | 41   |      |             |      |              |      | pF   |

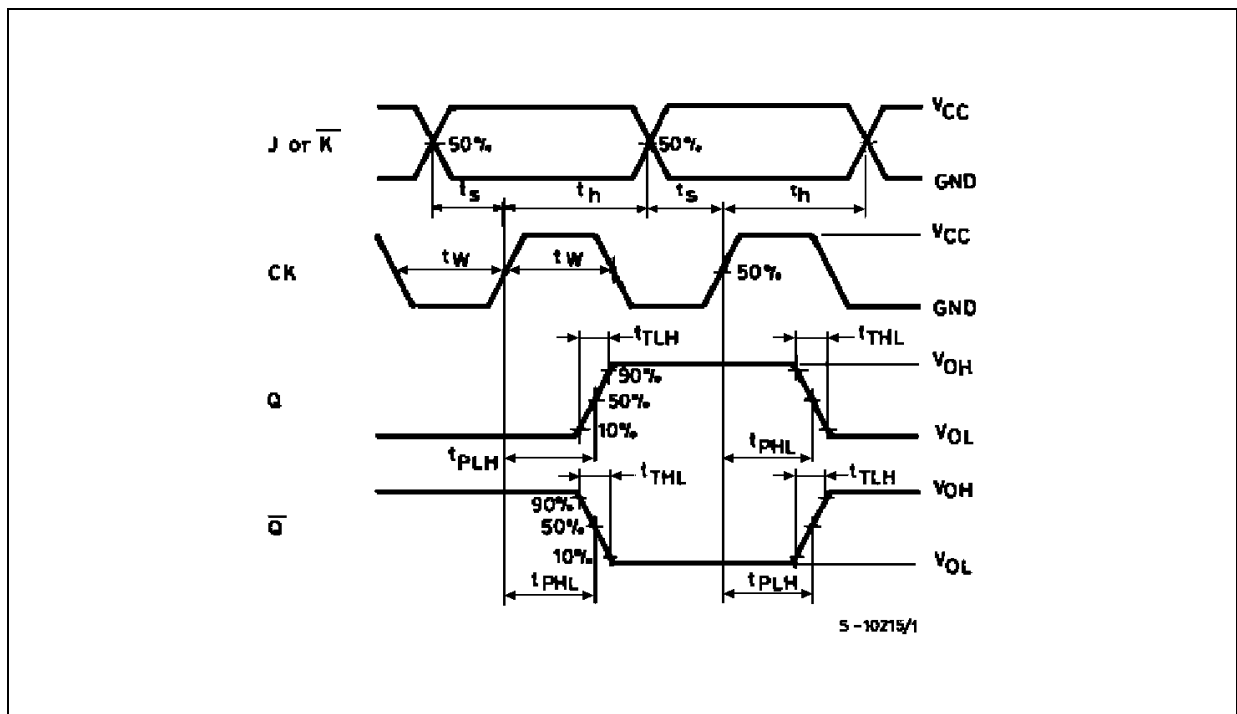
1)  $C_{PD}$  is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/2$  (per FLIP/FLOP)

## TEST CIRCUIT

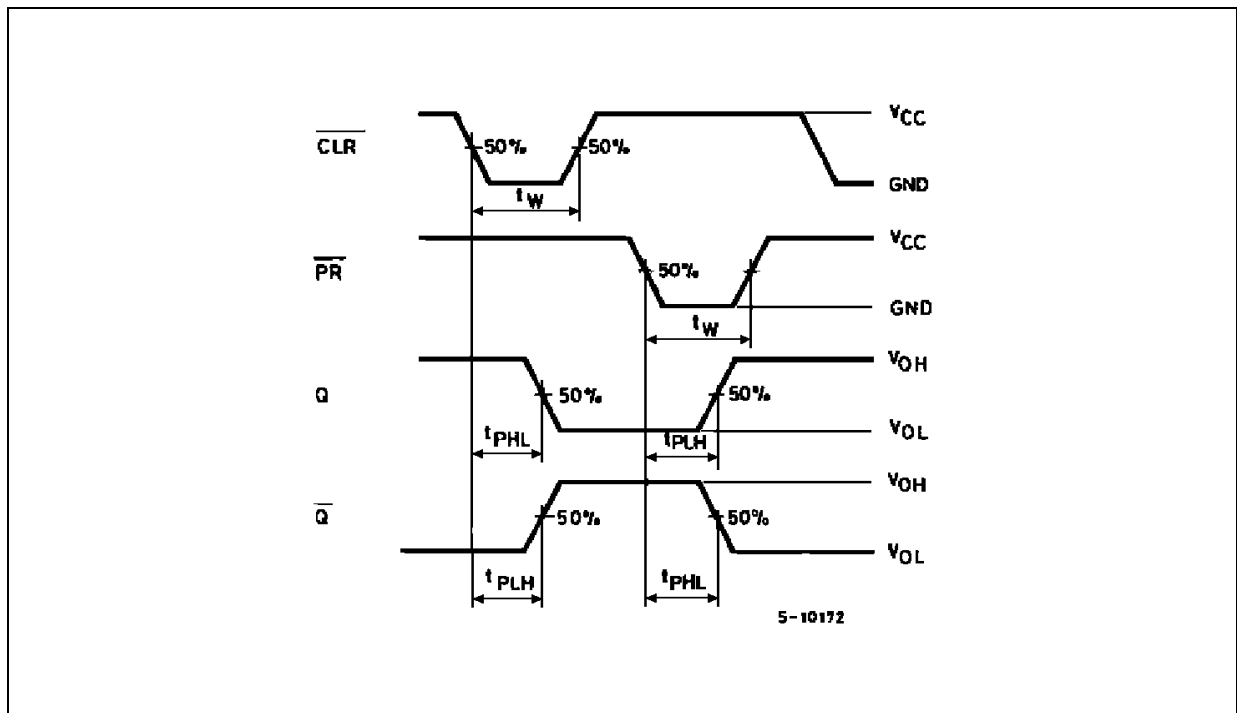


$C_L = 50\text{pF}$  or equivalent (includes jig and probe capacitance)  
 $R_T = Z_{OUT}$  of pulse generator (typically  $50\Omega$ )

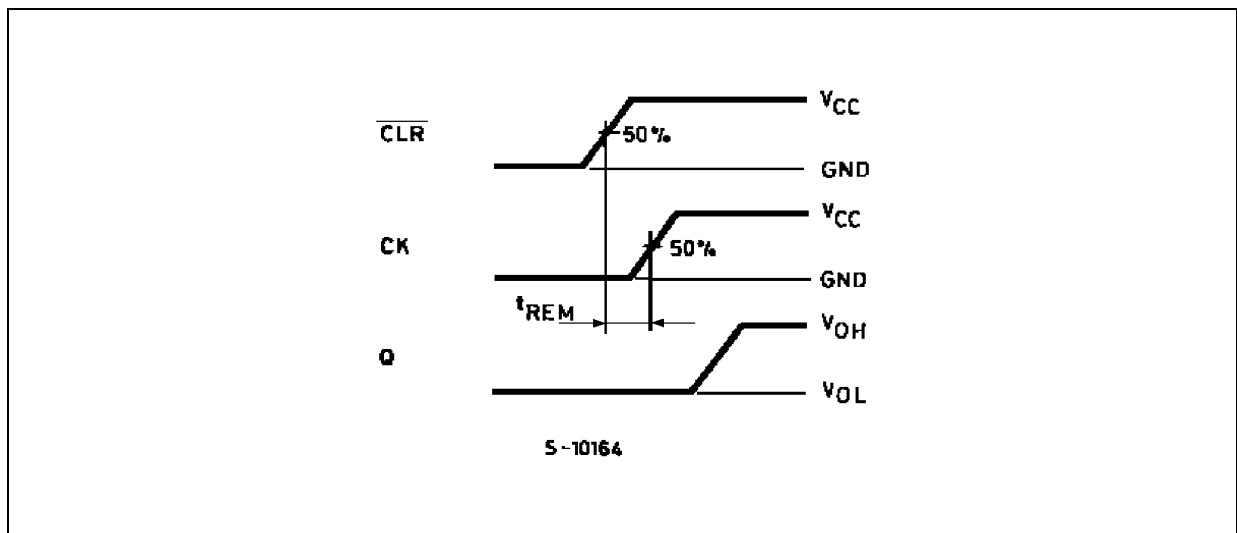
**WAVEFORM 1: PROPAGATION DELAY TIMES, SETUP AND HOLD TIMES, MINIMUM PULSE WIDTH (CK) ( $f=1\text{MHz}$ ; 50% duty cycle)**

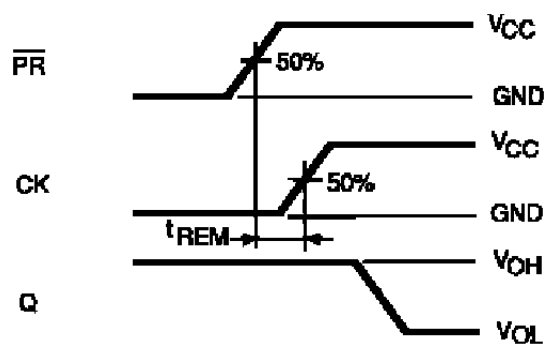


**WAVEFORM 2 : PROPAGATION DELAY TIMES , MINIMUM PULSE WIDTH ( $\overline{\text{CLR}}$ ), ( $\overline{\text{PR}}$ )**  
 (f=1MHz; 50% duty cycle)



**WAVEFORM 3 : MINIMUM REMOVAL TIME ( $\overline{\text{CLR}}$  to CK) (f=1MHz; 50% duty cycle)**



WAVEFORM 4 : MINIMUM REMOVAL TIME ( $\overline{\text{PR}}$  to CK) ( $f=1\text{MHz}$ ; 50% duty cycle)

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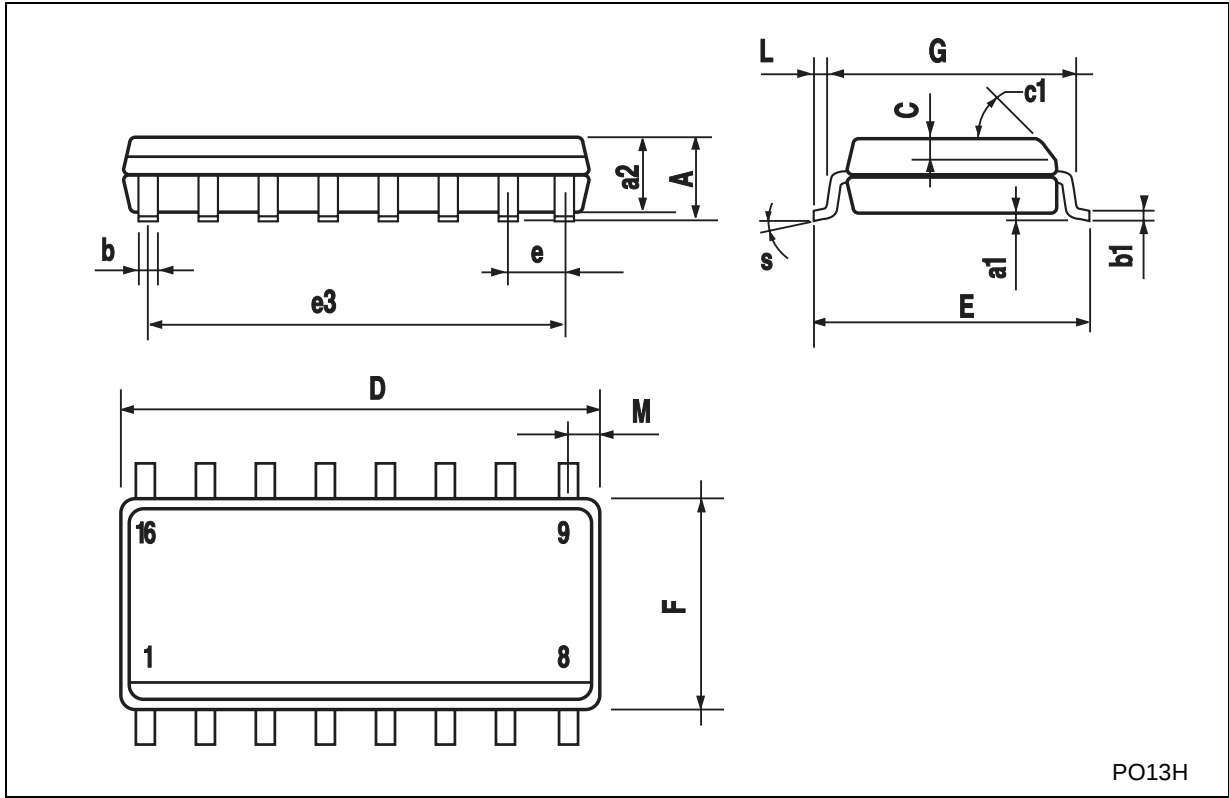
### Plastic DIP-16 (0.25) MECHANICAL DATA

| 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.)  |      |      |       |       |       |



## 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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