



# HCF4013B

## DUAL D-TYPE FLIP FLOP

- SET - RESET CAPABILITY
- STATIC FLIP-FLOP OPERATION - RETAINS STATE INDEFINITELY WITH CLOCK LEVEL EITHER "HIGH" OR "LOW"
- MEDIUM SPEED OPERATION 16MHz (TYP.) CLOCK TOGGLE RATE AT 10V
- STANDARDIZED SYMMETRICAL OUTPUT CHARACTERISTICS
- QUIESCENT CURRENT SPECIFIED UP TO 20V
- 5V, 10V AND 15V PARAMETRIC RATINGS
- INPUT LEAKAGE CURRENT  
 $I_I = 100\text{nA (MAX) AT } V_{DD} = 18\text{V } T_A = 25^\circ\text{C}$
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC JESD13B "STANDARD SPECIFICATIONS FOR DESCRIPTION OF B SERIES CMOS DEVICES"

### DESCRIPTION

The HCF4013B is a monolithic integrated circuit fabricated in Metal Oxide Semiconductor technology available in DIP and SOP packages. The HCF4013B consists of two identical, independent data type flip-flops. Each flip-flop has independent data, set, reset, and clock inputs and

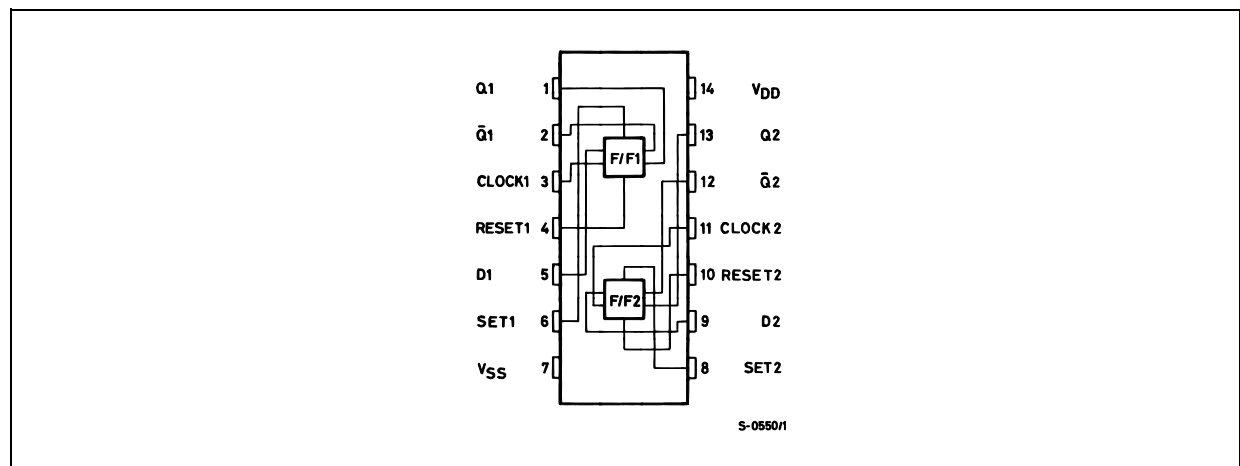


### ORDER CODES

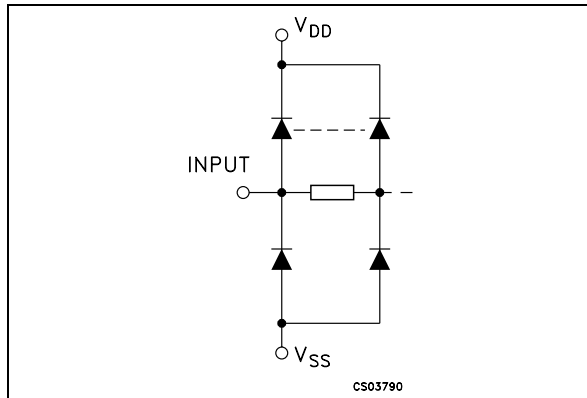
| PACKAGE | TUBE       | T & R         |
|---------|------------|---------------|
| DIP     | HCF4013BEY |               |
| SOP     | HCF4013BM1 | HCF4013M013TR |

Q and  $\bar{Q}$  outputs. This device can be used for shift register applications, and, by connecting  $\bar{Q}$  output to the data input, for counter and toggle applications. The logic level present at the D input is transferred to the  $\bar{Q}$  output during the positive-going transition of the clock pulse. Setting or resetting is independent of the clock and is accomplished by a high level on the set or reset line, respectively

### PIN CONNECTION



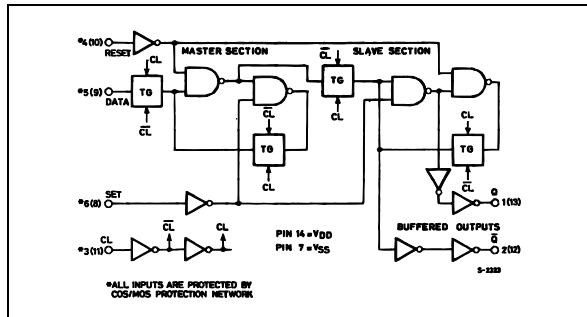
## INPUT EQUIVALENT CIRCUIT



## PIN DESCRIPTION

| PIN No | SYMBOL           | NAME AND FUNCTION       |
|--------|------------------|-------------------------|
| 3, 11  | CLOCK1<br>CLOCK2 | Clock Inputs            |
| 4, 10  | RESET1<br>RESET2 | Reset Inputs            |
| 6, 8   | SET1, SET2       | Set Inputs              |
| 5, 9   | D1, D2           | Data Inputs             |
| 1, 13  | Q1, Q2           | Data Outputs            |
| 2, 12  | Q1, Q2           | Data Outputs            |
| 7      | V <sub>SS</sub>  | Negative Supply Voltage |
| 14     | V <sub>DD</sub>  | Positive Supply Voltage |

## LOGIC DIAGRAM



## TRUTH TABLE

| CLOCK <sup>Δ</sup> | D | RESET | SET | Q | $\overline{Q}$ |
|--------------------|---|-------|-----|---|----------------|
|                    | L | L     | L   | L | H              |
|                    | H | L     | L   | H | L              |
|                    | X | L     | L   | Q | $\overline{Q}$ |
| X                  | X | H     | L   | L | H              |
| X                  | X | L     | H   | H | L              |
| X                  | X | H     | H   | H | H              |

X : Don't Care  
<sup>Δ</sup> : Low Level

## ABSOLUTE MAXIMUM RATINGS

| Symbol           | Parameter                               | Value                         | Unit |
|------------------|-----------------------------------------|-------------------------------|------|
| V <sub>DD</sub>  | Supply Voltage                          | -0.5 to +22                   | V    |
| V <sub>I</sub>   | DC Input Voltage                        | -0.5 to V <sub>DD</sub> + 0.5 | V    |
| I <sub>I</sub>   | DC Input Current                        | ± 10                          | mA   |
| P <sub>D</sub>   | Power Dissipation per Package           | 200                           | mW   |
|                  | Power Dissipation per Output Transistor | 100                           | mW   |
| T <sub>op</sub>  | Operating Temperature                   | -55 to +125                   | °C   |
| T <sub>stg</sub> | Storage Temperature                     | -65 to +150                   | °C   |

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

All voltage values are referred to V<sub>SS</sub> pin voltage.

## RECOMMENDED OPERATING CONDITIONS

| Symbol          | Parameter             | Value                | Unit |
|-----------------|-----------------------|----------------------|------|
| V <sub>DD</sub> | Supply Voltage        | 3 to 20              | V    |
| V <sub>I</sub>  | Input Voltage         | 0 to V <sub>DD</sub> | V    |
| T <sub>op</sub> | Operating Temperature | -55 to 125           | °C   |

## DC SPECIFICATIONS

| Symbol          | Parameter                 | Test Condition        |                       |                          |                        | Value                 |                   |      |             |      |              |      | Unit |
|-----------------|---------------------------|-----------------------|-----------------------|--------------------------|------------------------|-----------------------|-------------------|------|-------------|------|--------------|------|------|
|                 |                           | V <sub>I</sub><br>(V) | V <sub>O</sub><br>(V) | I <sub>O</sub>  <br>(μA) | V <sub>DD</sub><br>(V) | T <sub>A</sub> = 25°C |                   |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                 |                           |                       |                       |                          |                        | Min.                  | Typ.              | Max. | Min.        | Max. | Min.         | Max. |      |
| I <sub>L</sub>  | Quiescent Current         | 0/5                   |                       |                          | 5                      |                       | 0.02              | 1    |             | 30   |              | 30   | μA   |
|                 |                           | 0/10                  |                       |                          | 10                     |                       | 0.02              | 2    |             | 60   |              | 60   |      |
|                 |                           | 0/15                  |                       |                          | 15                     |                       | 0.02              | 4    |             | 120  |              | 120  |      |
|                 |                           | 0/20                  |                       |                          | 20                     |                       | 0.04              | 20   |             | 600  |              | 600  |      |
| V <sub>OH</sub> | High Level Output Voltage | 0/5                   |                       | <1                       | 5                      | 4.95                  |                   |      | 4.95        |      | 4.95         |      | V    |
|                 |                           | 0/10                  |                       | <1                       | 10                     | 9.95                  |                   |      | 9.95        |      | 9.95         |      |      |
|                 |                           | 0/15                  |                       | <1                       | 15                     | 14.95                 |                   |      | 14.95       |      | 14.95        |      |      |
| V <sub>OL</sub> | Low Level Output Voltage  | 5/0                   |                       | <1                       | 5                      |                       | 0.05              |      |             | 0.05 |              | 0.05 | V    |
|                 |                           | 10/0                  |                       | <1                       | 10                     |                       | 0.05              |      |             | 0.05 |              | 0.05 |      |
|                 |                           | 15/0                  |                       | <1                       | 15                     |                       | 0.05              |      |             | 0.05 |              | 0.05 |      |
| V <sub>IH</sub> | High Level Input Voltage  |                       | 0.5/4.5               | <1                       | 5                      | 3.5                   |                   |      | 3.5         |      | 3.5          |      | V    |
|                 |                           |                       | 1/9                   | <1                       | 10                     | 7                     |                   |      | 7           |      | 7            |      |      |
|                 |                           |                       | 1.5/13.5              | <1                       | 15                     | 11                    |                   |      | 11          |      | 11           |      |      |
| V <sub>IL</sub> | Low Level Input Voltage   |                       | 4.5/0.5               | <1                       | 5                      |                       |                   | 1.5  |             | 1.5  |              | 1.5  | V    |
|                 |                           |                       | 9/1                   | <1                       | 10                     |                       |                   | 3    |             | 3    |              | 3    |      |
|                 |                           |                       | 13.5/1.5              | <1                       | 15                     |                       |                   | 4    |             | 4    |              | 4    |      |
| I <sub>OH</sub> | Output Drive Current      | 0/5                   | 2.5                   | <1                       | 5                      | -1.36                 | -3.2              |      | -1.15       |      | -1.1         |      | mA   |
|                 |                           | 0/5                   | 4.6                   | <1                       | 5                      | -0.44                 | -1                |      | -0.36       |      | -0.36        |      |      |
|                 |                           | 0/10                  | 9.5                   | <1                       | 10                     | -1.1                  | -2.6              |      | -0.9        |      | -0.9         |      |      |
|                 |                           | 0/15                  | 13.5                  | <1                       | 15                     | -3.0                  | -6.8              |      | -2.4        |      | -2.4         |      |      |
| I <sub>OL</sub> | Output Sink Current       | 0/5                   | 0.4                   | <1                       | 5                      | 0.44                  | 1                 |      | 0.36        |      | 0.36         |      | mA   |
|                 |                           | 0/10                  | 0.5                   | <1                       | 10                     | 1.1                   | 2.6               |      | 0.9         |      | 0.9          |      |      |
|                 |                           | 0/15                  | 1.5                   | <1                       | 15                     | 3.0                   | 6.8               |      | 2.4         |      | 2.4          |      |      |
| I <sub>I</sub>  | Input Leakage Current     | 0/18                  | Any Input             |                          | 18                     |                       | ±10 <sup>-5</sup> | ±0.1 |             | ±1   |              | ±1   | μA   |
| C <sub>I</sub>  | Input Capacitance         |                       | Any Input             |                          |                        |                       | 5                 | 7.5  |             |      |              |      | pF   |

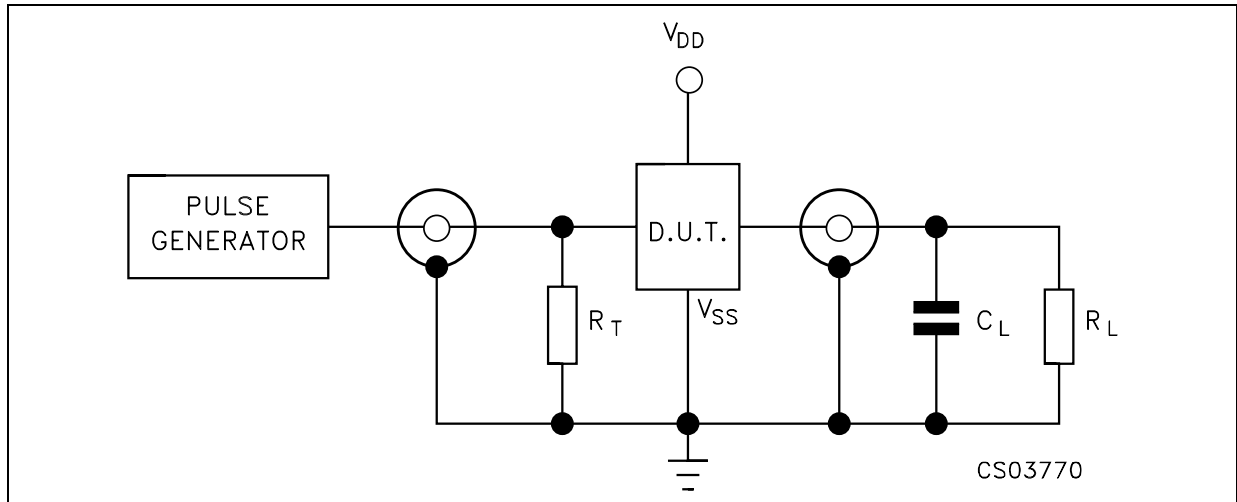
The Noise Margin for both "1" and "0" level is: 1V min. with V<sub>DD</sub>=5V, 2V min. with V<sub>DD</sub>=10V, 2.5V min. with V<sub>DD</sub>=15V

**DYNAMIC ELECTRICAL CHARACTERISTICS** ( $T_{amb} = 25^{\circ}\text{C}$ ,  $C_L = 50\text{pF}$ ,  $R_L = 200\text{K}\Omega$ ,  $t_r = t_f = 20\text{ ns}$ )

| Symbol              | Parameter                                                   | Test Condition |  | Value (*) |      |      | Unit          |
|---------------------|-------------------------------------------------------------|----------------|--|-----------|------|------|---------------|
|                     |                                                             | $V_{DD}$ (V)   |  | Min.      | Typ. | Max. |               |
| $t_{TLH}$ $t_{THL}$ | Propagation Delay Time<br>(CLOCK to Q or $\bar{Q}$ outputs) | 5              |  |           | 150  | 300  | ns            |
|                     |                                                             | 10             |  |           | 65   | 130  |               |
|                     |                                                             | 15             |  |           | 45   | 90   |               |
| $t_{PLH}$           | Propagation Delay Time<br>(SET to Q or RESET to $\bar{Q}$ ) | 5              |  |           | 150  | 300  | ns            |
|                     |                                                             | 10             |  |           | 65   | 130  |               |
|                     |                                                             | 15             |  |           | 45   | 90   |               |
| $t_{PHL}$           | Propagation Delay<br>Time(SET to Q or RESET<br>to Q)        | 5              |  |           | 200  | 400  | ns            |
|                     |                                                             | 10             |  |           | 85   | 170  |               |
|                     |                                                             | 15             |  |           | 60   | 120  |               |
| $t_{THL}$ $t_{TLH}$ | Transition Time                                             | 5              |  |           | 100  | 200  | ns            |
|                     |                                                             | 10             |  |           | 50   | 100  |               |
|                     |                                                             | 15             |  |           | 40   | 80   |               |
| $f_{CL}^{(1)}$      | Maximum Clock Input<br>Frequency                            | 5              |  | 3.5       | 7    |      | MHz           |
|                     |                                                             | 10             |  | 8         | 16   |      |               |
|                     |                                                             | 15             |  | 12        | 24   |      |               |
| $t_W$               | Clock Pulse Width                                           | 5              |  | 140       | 70   |      | ns            |
|                     |                                                             | 10             |  | 60        | 30   |      |               |
|                     |                                                             | 15             |  | 40        | 20   |      |               |
| $t_r$ , $t_f^{(2)}$ | Clock Input Rise or Fall<br>Time                            | 5              |  |           |      | 15   | $\mu\text{s}$ |
|                     |                                                             | 10             |  |           |      | 4    |               |
|                     |                                                             | 15             |  |           |      | 1    |               |
| $t_W$               | Set or Reset Pulse Width                                    | 5              |  | 180       | 90   |      | ns            |
|                     |                                                             | 10             |  | 80        | 40   |      |               |
|                     |                                                             | 15             |  | 50        | 25   |      |               |
| $t_{\text{setup}}$  | Data Setup Time                                             | 5              |  | 40        | 20   |      | ns            |
|                     |                                                             | 10             |  | 20        | 10   |      |               |
|                     |                                                             | 15             |  | 15        | 7    |      |               |

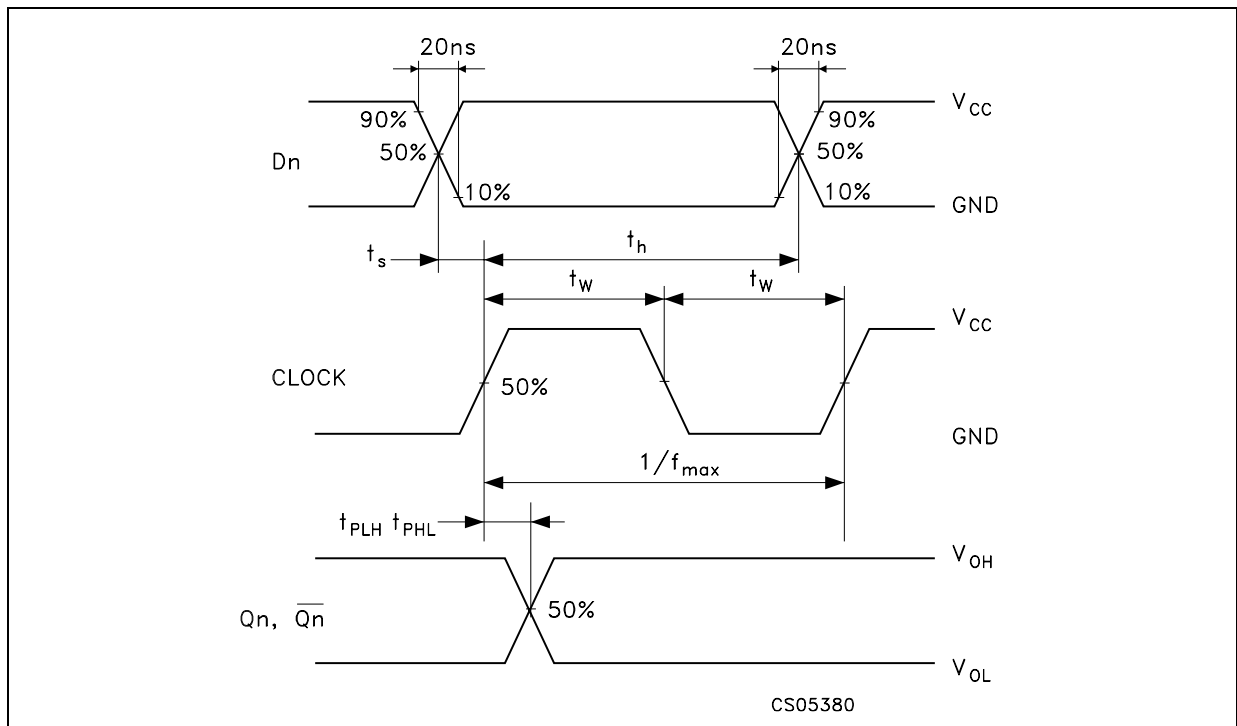
(\*) Typical temperature coefficient for all  $V_{DD}$  value is 0.3 %/ $^{\circ}\text{C}$ .(1) Input  $t_r$ ,  $t_f = 5\text{ns}$ (2) If more than unit is cascaded in a parallel clocked application,  $t_r$  should be made less than or equal to the sum of the fixed propagation delay time at 15pF and the transition time of the carry output driving stage for the estimated capacitive load.

## TEST CIRCUIT

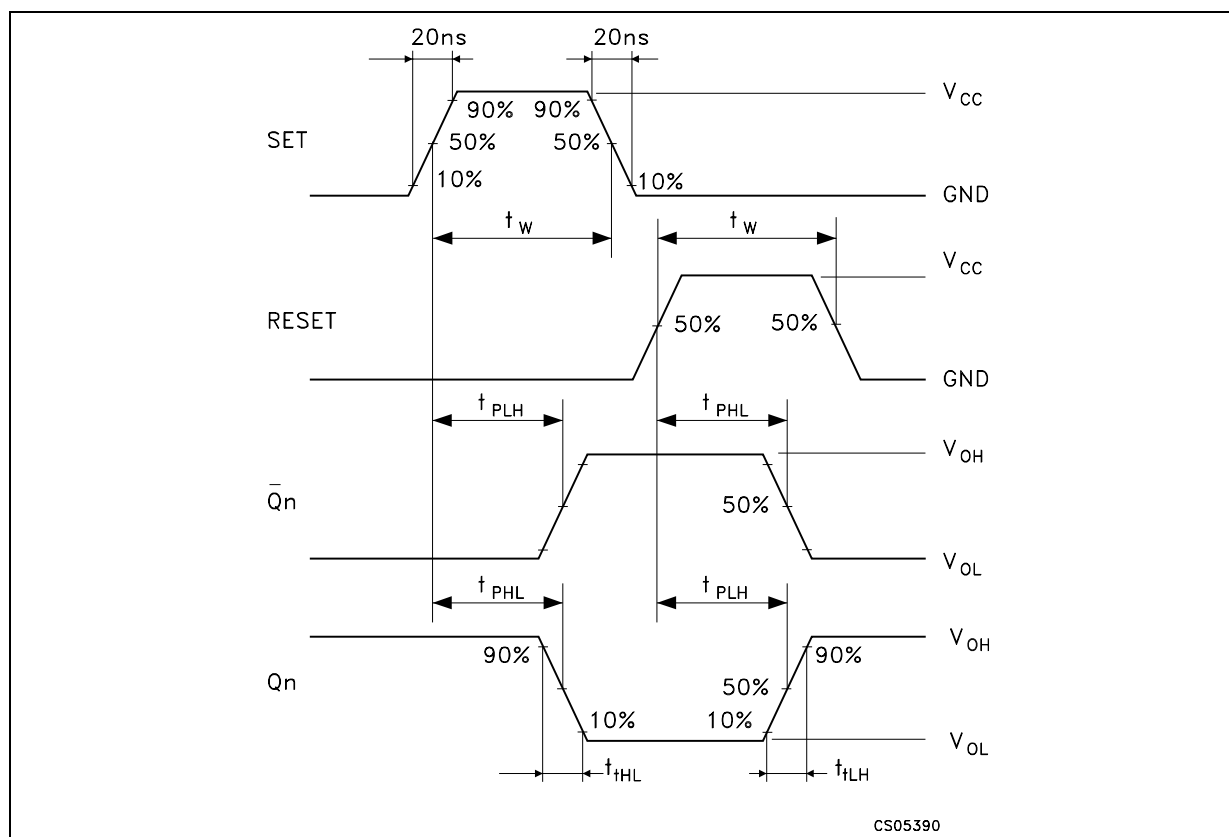


$C_L = 50\text{pF}$  or equivalent (includes jig and probe capacitance)  
 $R_L = 200\text{k}\Omega$   
 $R_T = Z_{OUT}$  of pulse generator (typically  $50\Omega$ )

**WAVEFORM 1 : CLOCK TO  $Q_n$ ,  $\overline{Q}_n$  PROPAGATION DELAY TIMES,  $D_n$  TO CLOCK SETUP AND HOLD TIMES, CLOCK MINIMUM PULSE WIDTH, MAXIMUM CLOCK FREQUENCY**  
 ( $f=1\text{MHz}$ ; 50% duty cycle)

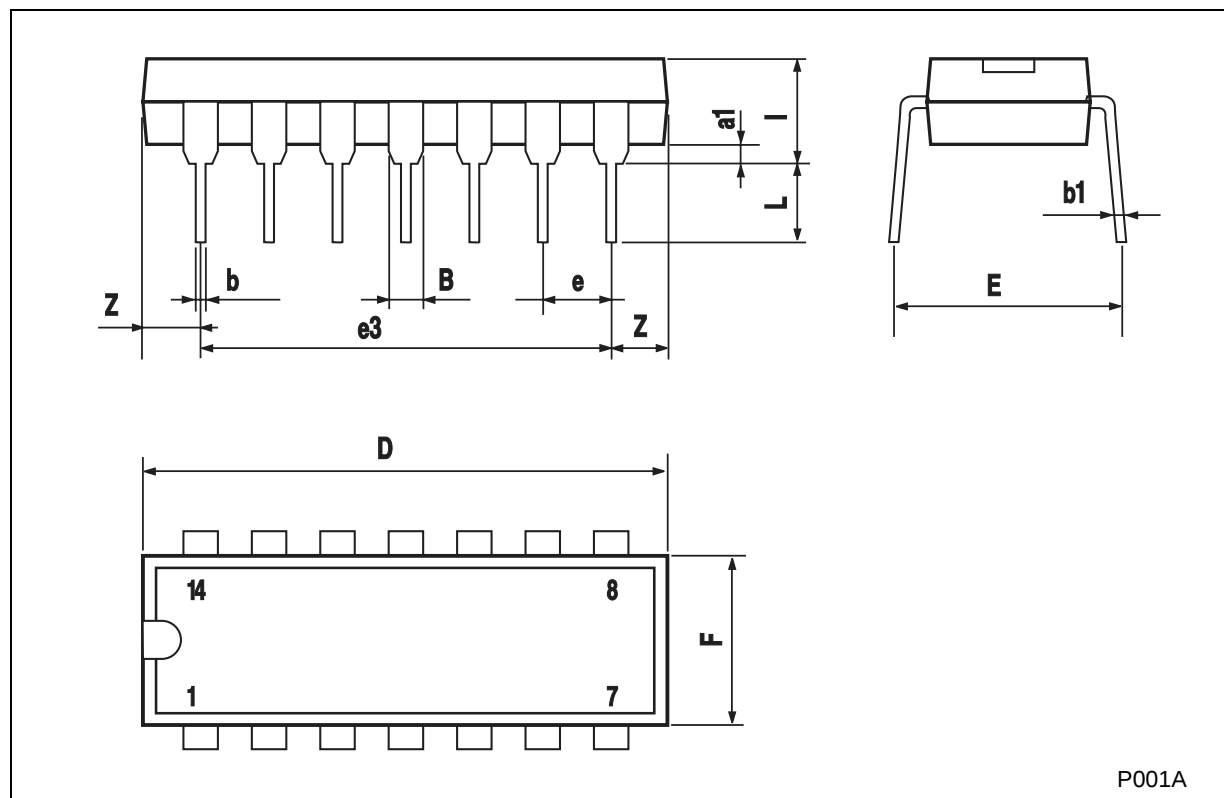


**WAVEFORM 2 : PROPAGATION DELAY TIMES ( $Q_n$ ,  $\bar{Q}_n$  TO SET, RESET), MINIMUM PULSE WIDTH (SET AND RESET) ( $f=1\text{MHz}$ ; 50% duty cycle)**



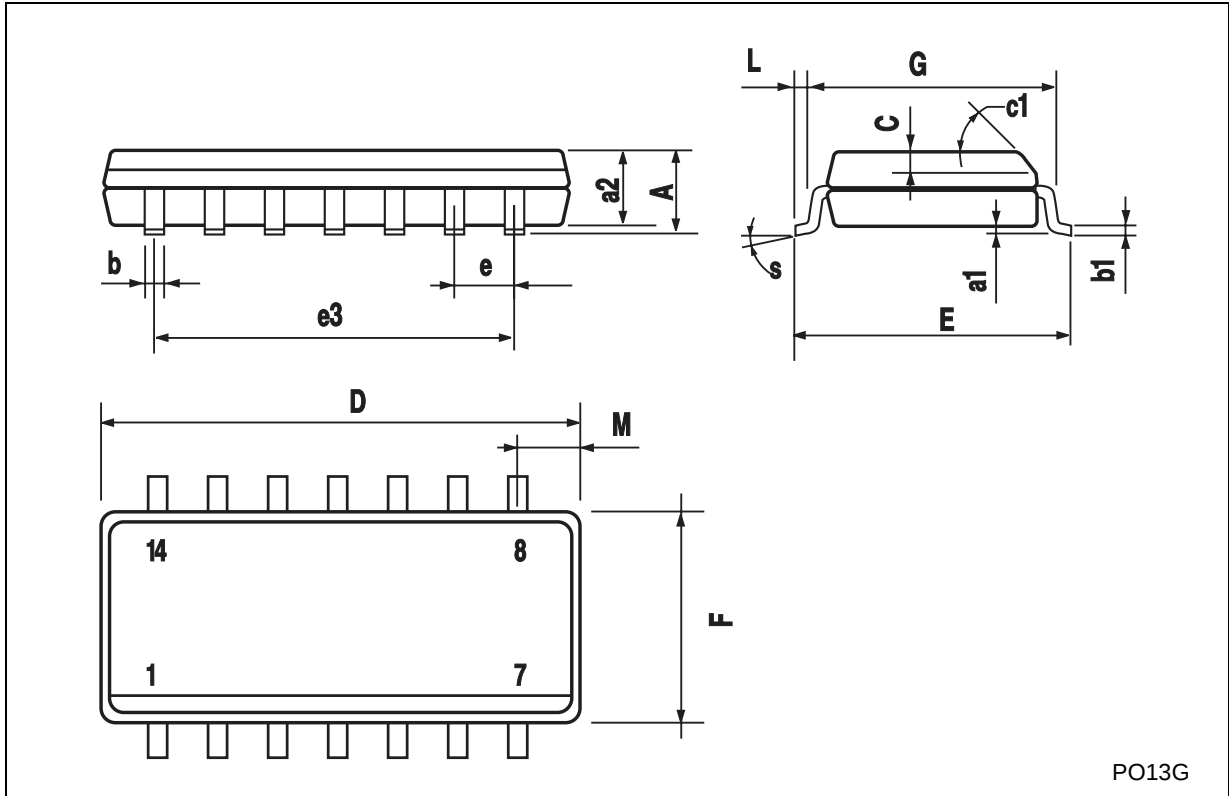
### Plastic DIP-14 MECHANICAL DATA

| DIM. | mm.  |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP   | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 1.39 |       | 1.65 | 0.055 |       | 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   |      | 15.24 |      |       | 0.600 |       |
| F    |      |       | 7.1  |       |       | 0.280 |
| I    |      |       | 5.1  |       |       | 0.201 |
| L    |      | 3.3   |      |       | 0.130 |       |
| Z    | 1.27 |       | 2.54 | 0.050 |       | 0.100 |



SO-14 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    | 8.55       |      | 8.75 | 0.336 |       | 0.344 |
| E    | 5.8        |      | 6.2  | 0.228 |       | 0.244 |
| e    |            | 1.27 |      |       | 0.050 |       |
| e3   |            | 7.62 |      |       | 0.300 |       |
| 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    |            |      | 0.68 |       |       | 0.026 |
| S    | 8° (max.)  |      |      |       |       |       |



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