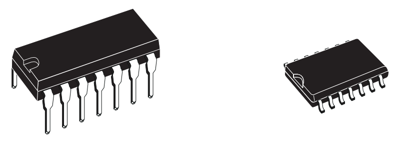
# HCF4096B

## GATED J-K MASTER SLAVE FLIP-FLOP

- 16MHz TOGGLE RATE (Typ.) at $V_{DD}$ - $V_{SS}$ = 10V
- GATED INPUTS
- QUIESCENT CURRENT SPECIFIED UP TO 20V
- 5V, 10V AND 15V PARAMETRIC RATINGS
- INPUT LEAKAGE CURRENT $I_I$ = 100nA (MAX) AT $V_{DD}$ = 18V $T_A$ = 25°C
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC JESD13B "STANDARD SPECIFICATIONS FOR DESCRIPTION OF B SERIES CMOS DEVICES"



DIP SOP

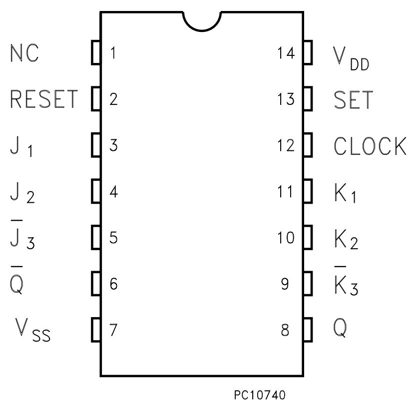
**ORDER CODES**

| PACKAGE | TUBE | T & R |
|---|---|---|
| DIP | HCF4096BEY | |
| SOP | HCF4096BM1 | HCF4096M013TR |

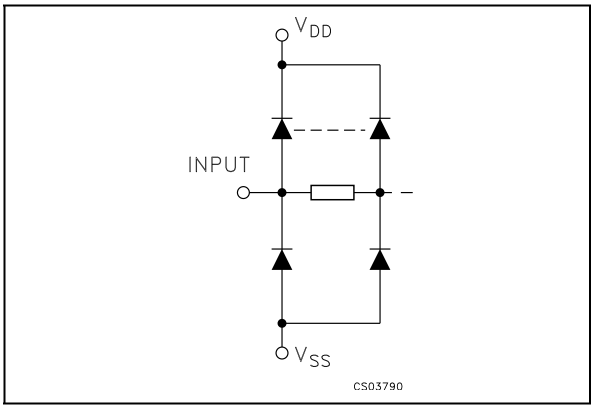
### DESCRIPTION

HCF4096B is a monolithic integrated circuit fabricated in Metal Oxide Semiconductor technology available in DIP and SOP packages.
HCF4096B is a J-K Master-Slave Flip-Flop featuring separate AND gating of multiple J and K inputs. The gated J-K input control transfers information into the master section during clocked operation. Information on the J-K inputs is transferred to the Q and $\overline{Q}$ outputs on the positive edge of the clock pulse. SET and RESET inputs (active high) are provided for asynchronous operation.

### PIN CONNECTION



## INPUT EQUIVALENT CIRCUIT




## PIN DESCRIPTION

| PIN No | SYMBOL | NAME AND FUNCTION |
|---|---|---|
| 3, 4, 5 | J1, J2, $\overline{J3}$ | J Inputs |
| 11, 10, 9 | K1, K2, $\overline{K3}$ | K Inputs |
| 8 | Q | Q Output |
| 6 | $\overline{Q}$ | $\overline{Q}$ Output |
| 13 | SET (S) | Set Inputs(Active High) |
| 2 | RESET (R) | Reset Inputs(Active High) |
| 12 | CLOCK | Clock Inputs |
| 1 | NC | Not Connected |
| 7 | $V_{SS}$ | Negative Supply Voltage |
| 14 | $V_{DD}$ | Positive Supply Voltage |

**TRUTH TABLE :** SYNCHRONOUS OPERATION (S=0 R=0)

| INPUTS BEFORE POSITIVE CLOCK TRANSITION | | OUTPUTS AFTER POSITIVE CLOCK TRANSITION | |
|---|---|---|---|
| **J*** | **K*** | **Q** | **$\overline{Q}$** |
| L | L | NO CHANGE | |
| L | H | L | H |
| H | L | H | L |
| H | H | TOGGLES | |

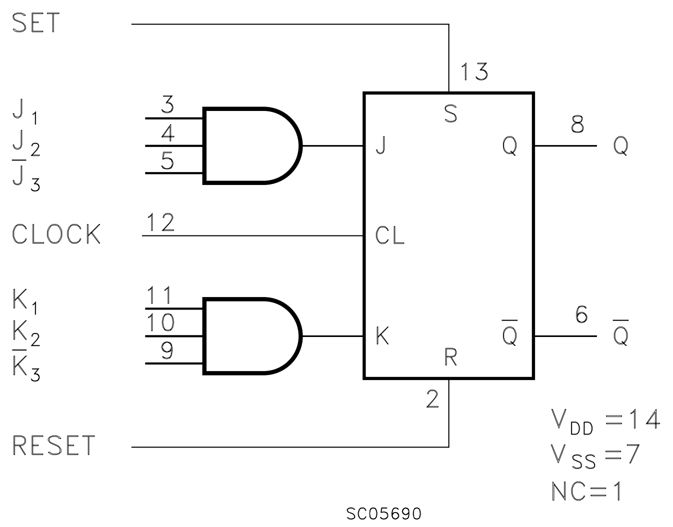
(*) : J=J1 • J2 • $\overline{J3}$, K=K1 • K2 • $\overline{K3}$

**TRUTH TABLE :** ASYNCHRONOUS OPERATION (J and K DON'T CARE)

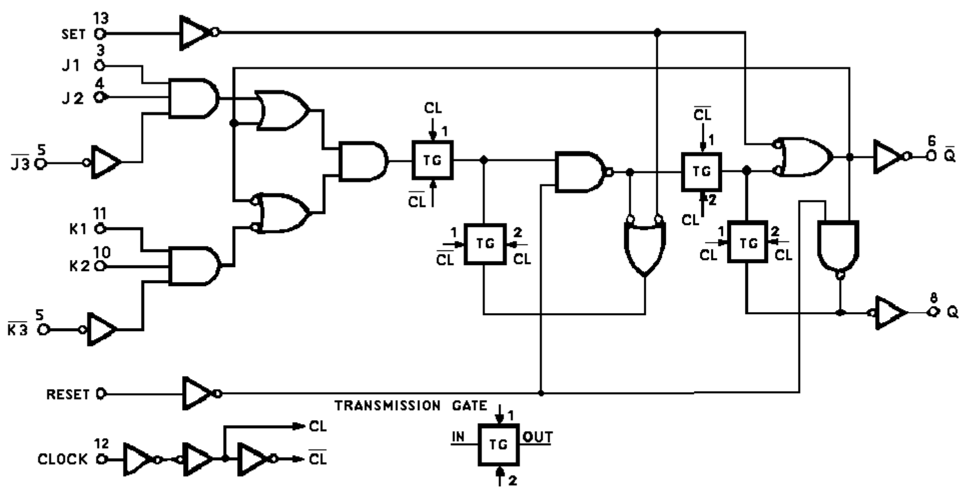
| INPUTS BEFORE POSITIVE CLOCK TRANSITION | | OUTPUTS AFTER POSITIVE CLOCK TRANSITION | |
|---|---|---|---|
| **S** | **R** | **Q** | **$\overline{Q}$** |
| L | L | NO CHANGE | |
| L | H | L | H |
| H | L | H | L |
| H | H | L | L |

(*) : L = Vss, H = Vdd

**FUNCTIONAL DIAGRAM**




**LOGIC DIAGRAM**




INPUT TO OUTPUT FOR TRANSMISSION GATE IS :
a) A BIDIRECTION LOW IMPEDANCE WHEN CONTROL INPUT 1 IS "LOW" AND CONTROL INPUT 2 IS "HIGH"
b) AN OPEN CIRCUIT WHEN CONTROL INPUT 1 IS "HIGH" AND CONTROL INPUT 2 IS "LOW"

## ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DD}$ | Supply Voltage | -0.5 to +22 | V |
| $V_I$ | DC Input Voltage | -0.5 to $V_{DD}$ + 0.5 | V |
| $I_I$ | DC Input Current | ± 10 | mA |
| $P_D$ | Power Dissipation per Package | 200 | mW |
| | Power Dissipation per Output Transistor | 100 | mW |
| $T_{op}$ | Operating Temperature | -55 to +125 | °C |
| $T_{stg}$ | Storage Temperature | -65 to +150 | °C |

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

All voltage values are referred to $V_{SS}$ pin voltage.

## RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DD}$ | Supply Voltage | 3 to 20 | V |
| $V_I$ | Input Voltage | 0 to $V_{DD}$ | V |
| $T_{op}$ | Operating Temperature | -55 to 125 | °C |

## DC SPECIFICATIONS

| Symbol | Parameter | Test Condition | | | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_I$ (V) | $V_O$ (V) | $\lvert I_O \rvert$ (μA) | $V_{DD}$ (V) | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $I_L$ | 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 | |
| $V_{OH}$ | 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 | | |
| $V_{OL}$ | 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 | |
| $V_{IH}$ | 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 | | |
| $V_{IL}$ | 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 | |
| $I_{OH}$ | 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 | | |
| $I_{OL}$ | 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 | | |

| Symbol | Parameter | Test Condition | | | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_I$ (V) | $V_O$ (V) | $\|I_O\|$ ($\mu$A) | $V_{DD}$ (V) | $T_A = 25°C$ | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $I_I$ | Input Leakage Current | 0/18 | Any Input | | 18 | | $\pm 10^{-5}$ | ±0.1 | | ±1 | | ±1 | µA |
| $C_I$ | Input Capacitance | | Any Input | | | | 5 | 7.5 | | | | | pF |

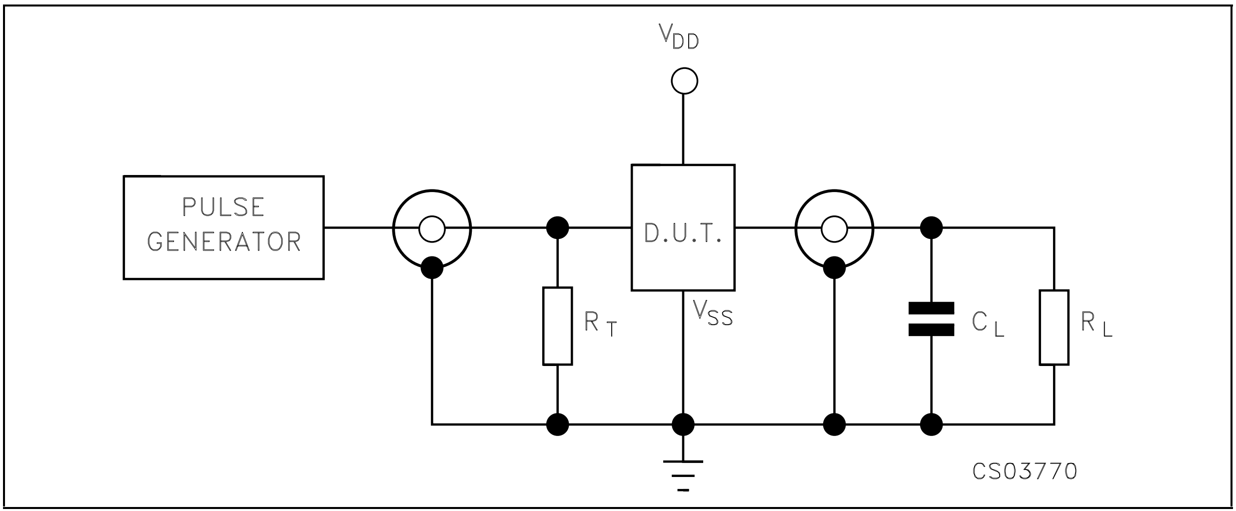
The Noise Margin for both "1" and "0" level is: 1V min. with $V_{DD}$=5V, 2V min. with $V_{DD}$=10V, 2.5V min. with $V_{DD}$=15V

**DYNAMIC ELECTRICAL CHARACTERISTICS** ($T_{amb}$ = 25°C, $C_L$ = 50pF, $R_L$ = 200KΩ, $t_r = t_f$ = 20 ns)

| Symbol | Parameter | Test Condition | | Value (*) | | | Unit |
|---|---|---|---|---|---|---|---|
| | | $V_{DD}$ (V) | | Min. | Typ. | Max. | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time | 5 | | | 250 | 500 | ns |
| | | 10 | | | 100 | 200 | |
| | | 15 | | | 75 | 150 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (Set or Reset) | 5 | | | 150 | 300 | ns |
| | | 10 | | | 75 | 150 | |
| | | 15 | | | 50 | 100 | |
| $t_{TLH}$ $t_{THL}$ | Transition Time | 5 | | | 100 | 200 | ns |
| | | 10 | | | 50 | 100 | |
| | | 15 | | | 40 | 80 | |
| $f_{CL}$ | Maximum Clock Input 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 | | |
| $t_r$, $t_f$ | Clock input Rise or Fall Time | 5 | | | | 15 | µs |
| | | 10 | | | | 5 | |
| | | 15 | | | | 5 | |
| $t_W$ | Set or Reset Pulse Width | 5 | | 200 | 100 | | ns |
| | | 10 | | 100 | 50 | | |
| | | 15 | | 50 | 25 | | |
| $t_{setup}$ | Data Setup Time | 5 | | 400 | 200 | | ns |
| | | 10 | | 160 | 80 | | |
| | | 15 | | 100 | 50 | | |

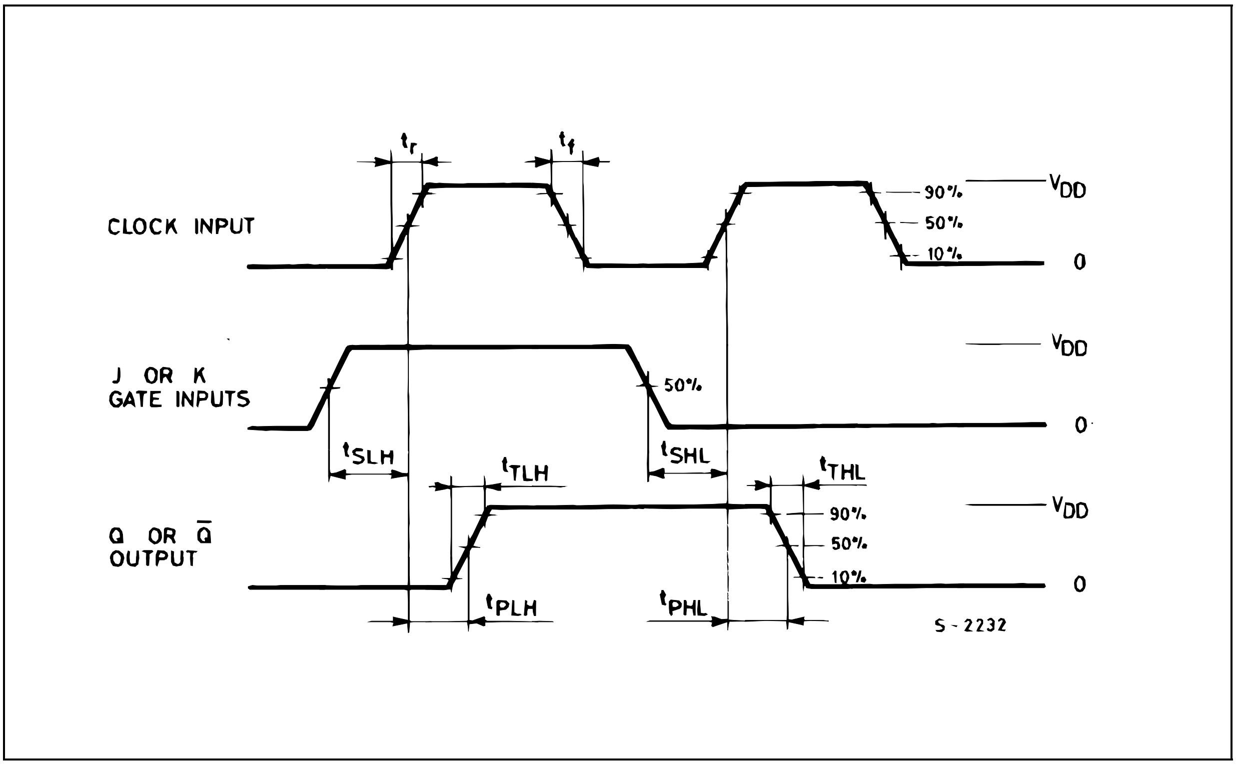
(*) Typical temperature coefficient for all $V_{DD}$ value is 0.3 %/°C.

## TEST CIRCUIT

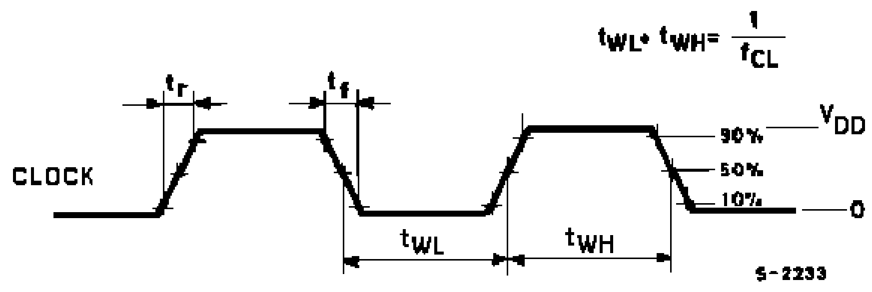



$C_L$ = 50pF or equivalent (includes jig and probe capacitance)
$R_L$ = 200KΩ
$R_T$ = $Z_{OUT}$ of pulse generator (typically 50Ω)

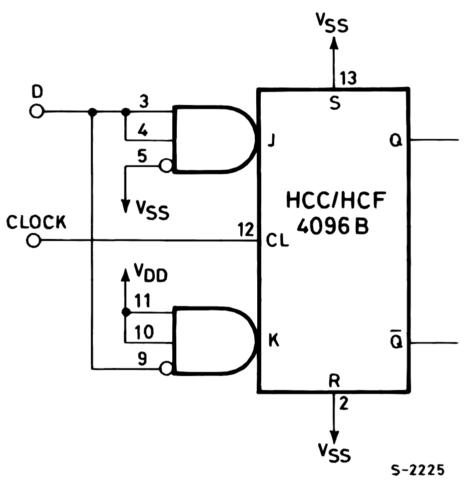
## WAVEFORM : PROPAGATION DELAY TRANSITION AND SETUP TIME



**WAVEFORM : CLOCK PULSE, RISE AND FALL TIME**

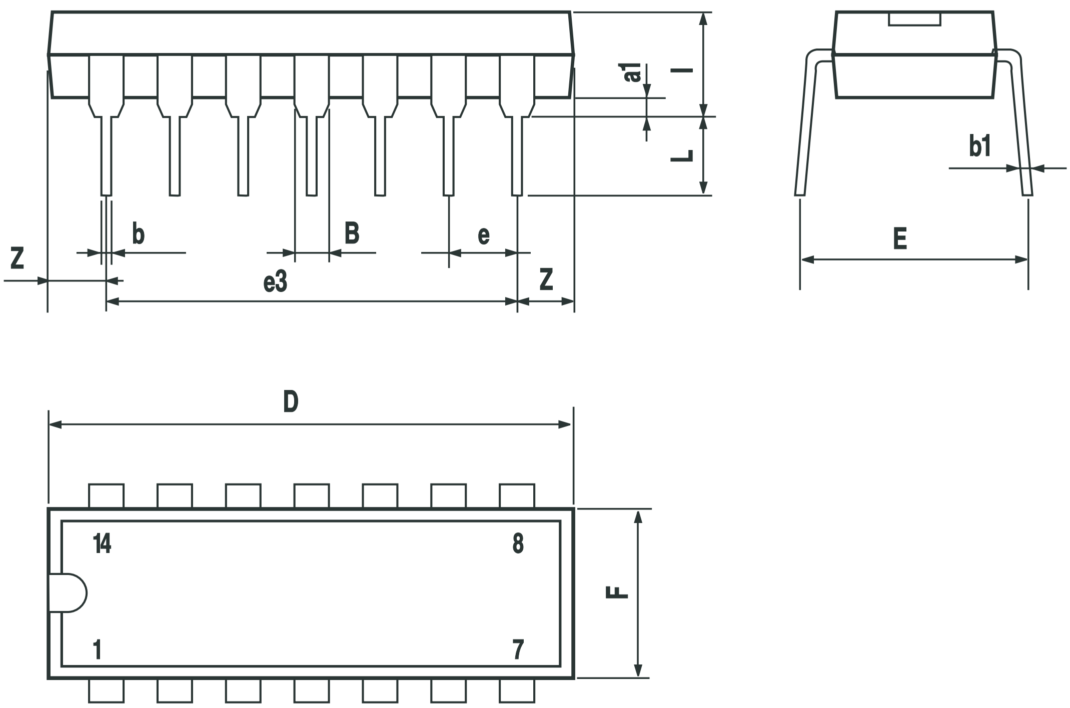



**TYPICAL APPLICATION :** D - TYPE FLIP FLOP



## Plastic DIP-14 MECHANICAL DATA

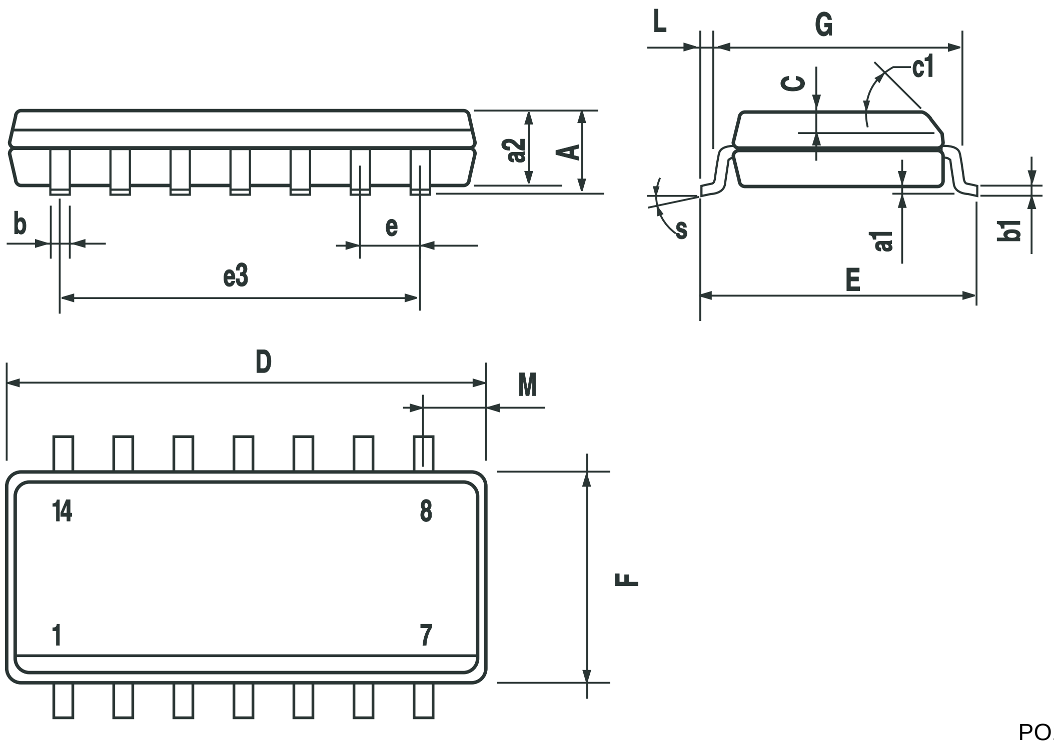
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 1.39 | | 1.65 | 0.055 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 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 |




P001A

## 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.) | | | | | |




PO13G