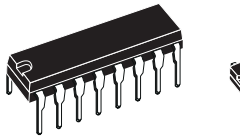
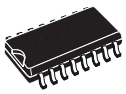
# M74HC192

## SYNCHRONOUS UP/DOWN DECADE COUNTER

- HIGH SPEED :
  $f_{MAX}$ = 55 MHz (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 192



DIP



SOP

TSSOP

**ORDER CODES**

| PACKAGE | TUBE | T & R |
|---|---|---|
| DIP | M74HC192B1R | |
| SOP | M74HC192M1R | M74HC192RM13TR |
| TSSOP | | M74HC192TTR |

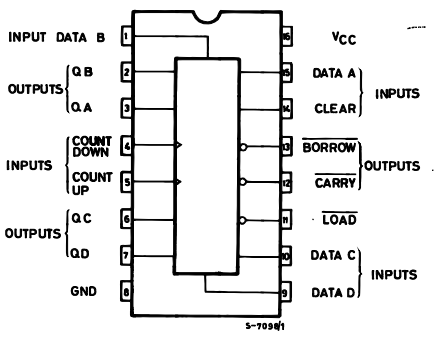
### DESCRIPTION

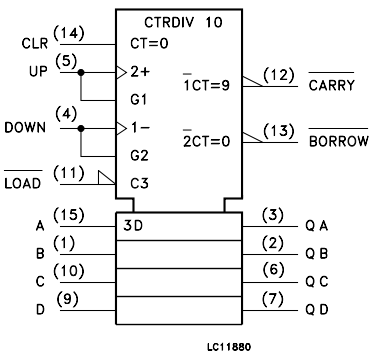
The M74HC192 is an high speed CMOS SYNCRONOUS UP/DOWN DECADE COUNTERS fabricated with silicon gate $C^2MOS$ technology.

The counter has two separate clock inputs, an UP COUNT input and a DOWN COUNT input. All outputs of the flip-flop are simultaneously triggered on the low to high transition of either clock while the other input is held high. The direction of counting is determined by which input is clocked. This counter may be preset by entering the desired data on the DATA A, DATA B, DATA C, and DATA D input. When the LOAD input is taken low the data is loaded independently of either clock input. This feature allows the counters to be used as divide-by-n counters by modifying the count length with the preset inputs. In addition the counter can also be cleared. This is accomplished by inputting a high on the CLEAR input. All 4 internal stages are set to low independently of either COUNT input. Both a BORROW and CARRY output are provided to enable cascading of both up and down counting functions. The BORROW output produces a negative going pulse when the counter underflows and the CARRY outputs a pulse when the counters overflows. The counter can be cascaded by connection the CARRY and BORROW outputs of one device to the COUNT UP and COUNT DOWN inputs, respectively, of the next device.

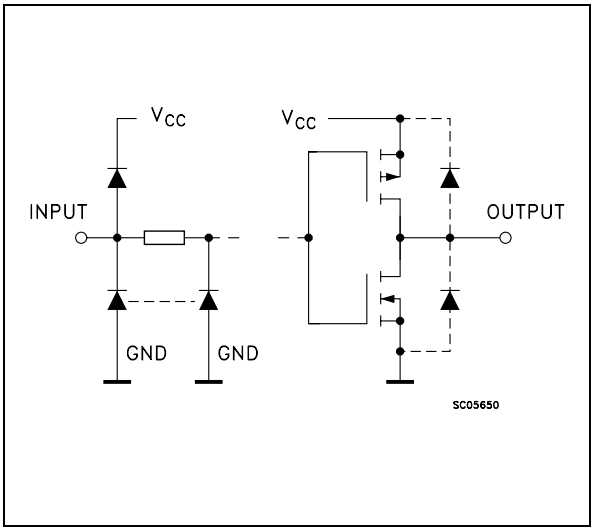
All inputs are equipped with protection circuits against static discharge and transient excess voltage.

### PIN CONNECTION AND IEC LOGIC SYMBOLS



## INPUT AND OUTPUT EQUIVALENT CIRCUIT




## PIN DESCRIPTION

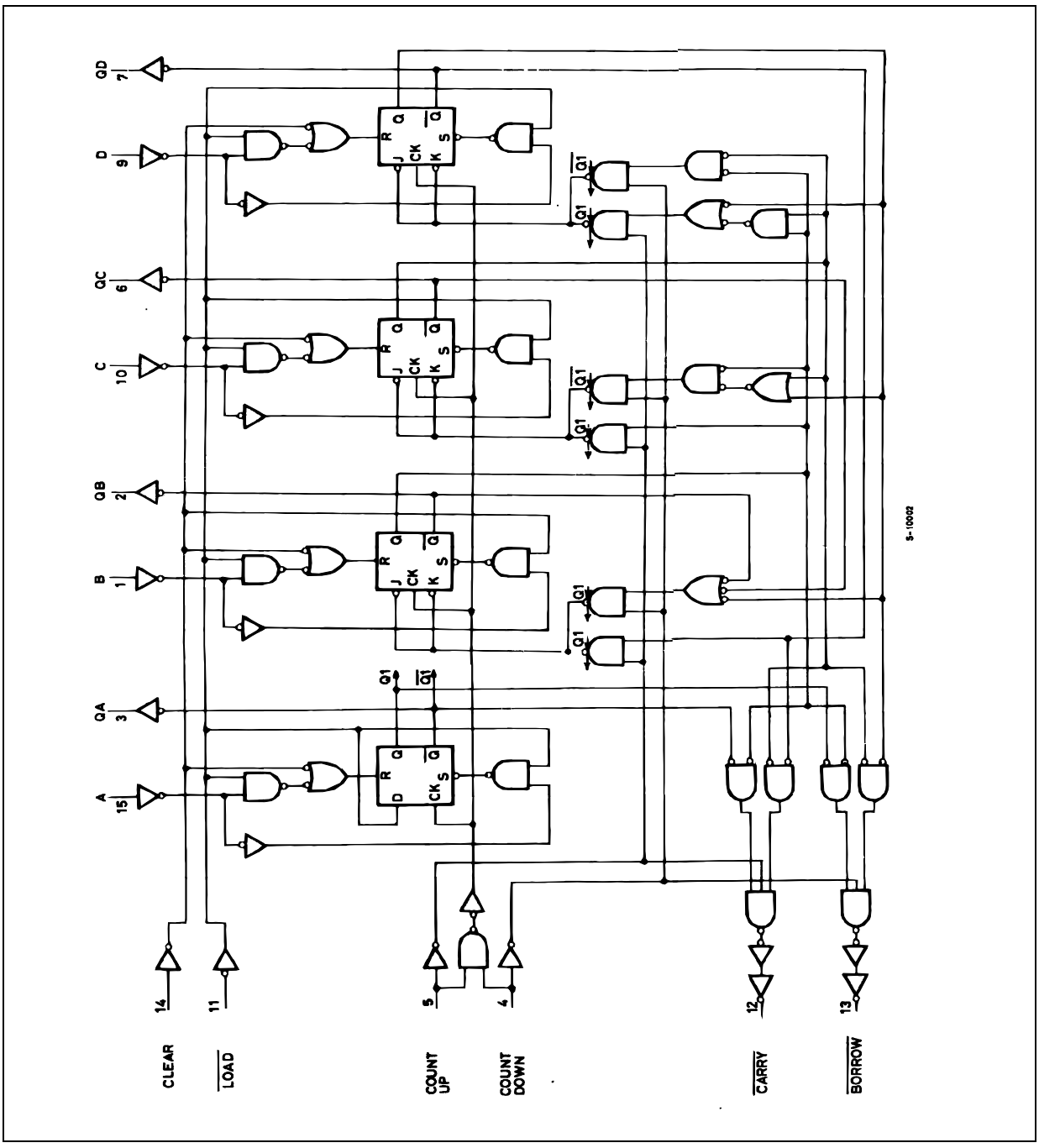
| PIN No | SYMBOL | NAME AND FUNCTION |
|---|---|---|
| 3, 2, 6, 7 | QA to QD | Flip-Flop Outputs |
| 4 | COUNT DOWN | Count Down Clock Input |
| 5 | COUNT UP | Count Up Clock Input |
| 11 | $\overline{\text{LOAD}}$ | Asynchronous Parallel Load Input (Active LOW) |
| 12 | $\overline{\text{CARRY}}$ | Count Up (Carry) Output (Active LOW) |
| 13 | $\overline{\text{BORROW}}$ | Count Down (Borrow) Output (Active LOW) |
| 14 | CLEAR | Asynchronous Reset Input (Active High) |
| 15, 1, 10, 9 | A to D | Data Inputs |
| 8 | GND | Ground (0V) |
| 16 | Vcc | Positive Supply Voltage |

## TRUTH TABLE

| COUNT UP | COUNT DOWN | $\overline{\text{LOAD}}$ | CLEAR | FUNCTION |
|---|---|---|---|---|
| ⌐¬ | H | H | L | COUNT UP |
| ¬⌐ | H | H | L | NO COUNT |
| H | ⌐¬ | H | L | COUNT DOWN |
| H | ¬⌐ | H | L | NO COUNT |
| X | X | L | L | PRESET |
| X | X | X | H | RESET |

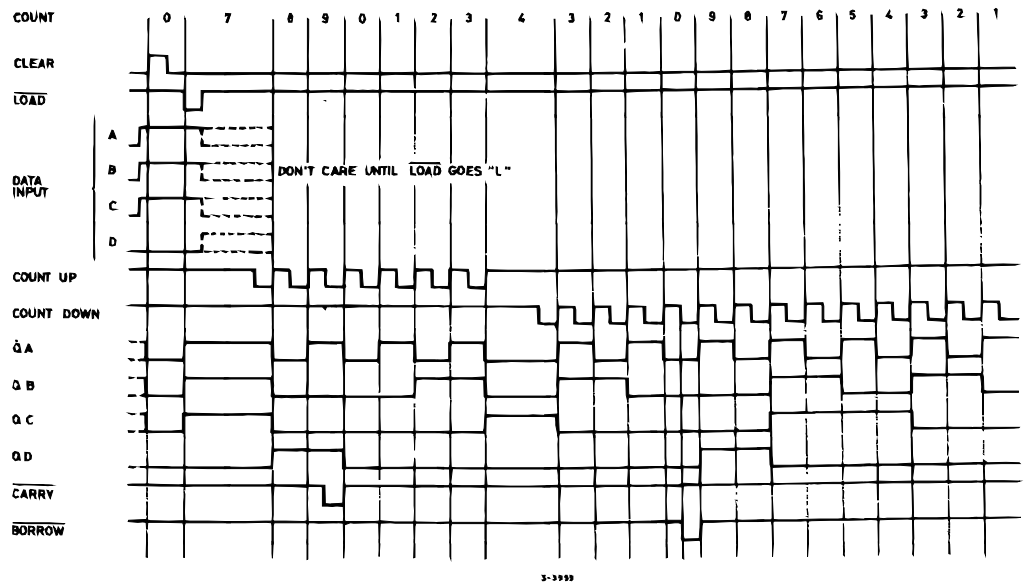
X : Don't Care

## 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 | ± 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 (COUNT UP, DOWN - Q) | 2.0 | | | 65 | 190 | | 240 | | 285 | ns |
| | | 4.5 | | | 20 | 38 | | 48 | | 57 | |
| | | 6.0 | | | 16 | 32 | | 41 | | 48 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (COUNT UP - $\overline{\text{CARRY}}$) | 2.0 | | | 40 | 130 | | 165 | | 195 | ns |
| | | 4.5 | | | 13 | 26 | | 33 | | 39 | |
| | | 6.0 | | | 11 | 22 | | 28 | | 33 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (COUNT DOWN - $\overline{\text{BORROW}}$) | 2.0 | | | 40 | 130 | | 165 | | 195 | ns |
| | | 4.5 | | | 13 | 26 | | 33 | | 39 | |
| | | 6.0 | | | 11 | 22 | | 28 | | 33 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (LOAD - Q) | 2.0 | | | 85 | 220 | | 275 | | 330 | ns |
| | | 4.5 | | | 25 | 44 | | 55 | | 66 | |
| | | 6.0 | | | 20 | 37 | | 47 | | 56 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (LOAD - $\overline{\text{CARRY}}$) | 2.0 | | | 110 | 250 | | 315 | | 375 | ns |
| | | 4.5 | | | 30 | 50 | | 63 | | 75 | |
| | | 6.0 | | | 25 | 43 | | 54 | | 64 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (LOAD - $\overline{\text{BORROW}}$) | 2.0 | | | 110 | 250 | | 315 | | 375 | ns |
| | | 4.5 | | | 31 | 50 | | 63 | | 75 | |
| | | 6.0 | | | 25 | 43 | | 54 | | 64 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (DATA - Q) | 2.0 | | | 80 | 190 | | 240 | | 285 | ns |
| | | 4.5 | | | 25 | 38 | | 48 | | 57 | |
| | | 6.0 | | | 20 | 32 | | 41 | | 48 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (DATA - $\overline{\text{CARRY}}$) | 2.0 | | | 120 | 250 | | 315 | | 375 | ns |
| | | 4.5 | | | 34 | 50 | | 63 | | 75 | |
| | | 6.0 | | | 28 | 43 | | 54 | | 64 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (DATA - $\overline{\text{BORROW}}$) | 2.0 | | | 110 | 250 | | 315 | | 375 | ns |
| | | 4.5 | | | 30 | 50 | | 63 | | 75 | |
| | | 6.0 | | | 25 | 43 | | 54 | | 64 | |
| $t_{PHL}$ | Propagation Delay Time (CLEAR -Q) | 2.0 | | | 100 | 225 | | 280 | | 340 | ns |
| | | 4.5 | | | 30 | 45 | | 56 | | 68 | |
| | | 6.0 | | | 25 | 38 | | 48 | | 58 | |
| $t_{PLH}$ | Propagation Delay Time (CLEAR -$\overline{\text{CARRY}}$) | 2.0 | | | 120 | 250 | | 315 | | 375 | ns |
| | | 4.5 | | | 35 | 50 | | 63 | | 75 | |
| | | 6.0 | | | 29 | 43 | | 54 | | 64 | |
| $t_{PHL}$ | Propagation Delay Time (CLEAR - $\overline{\text{BORROW}}$) | 2.0 | | | 120 | 250 | | 315 | | 375 | ns |
| | | 4.5 | | | 35 | 50 | | 63 | | 75 | |
| | | 6.0 | | | 29 | 43 | | 54 | | 64 | |
| $f_{MAX}$ | Maximum Clock Frequency | 2.0 | | 5 | 12 | | 4 | | 3.4 | | MHz |
| | | 4.5 | | 25 | 48 | | 20 | | 17 | | |
| | | 6.0 | | 30 | 55 | | 24 | | 20 | | |

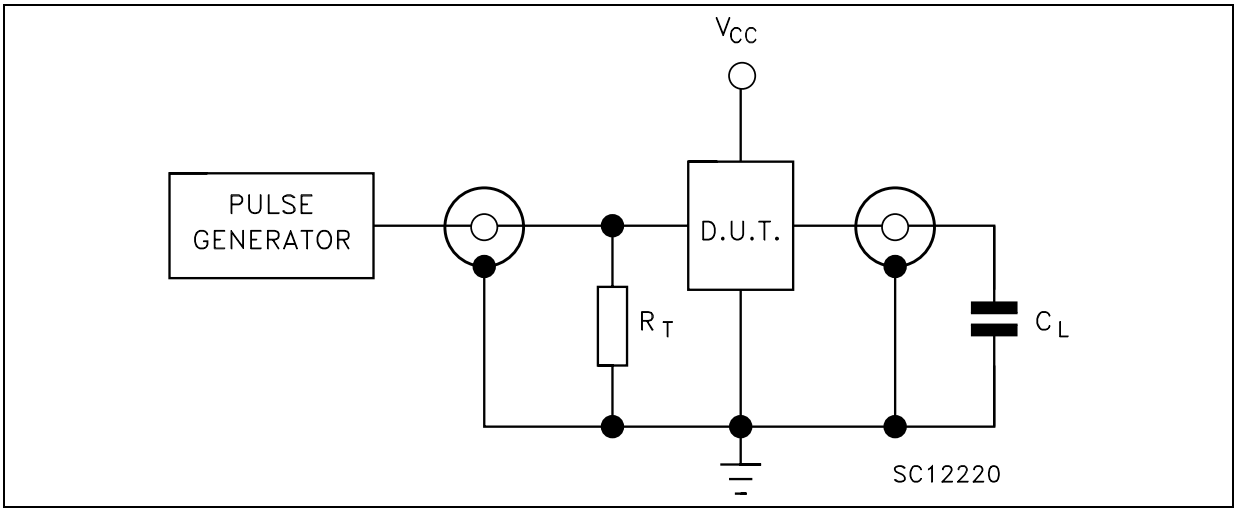
| Symbol | Parameter | Test Condition | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $t_{W(H)}$ $t_{W(L)}$ | Minimum Pulse Width (COUNT UP/ DOWN) | 2.0 | | | 34 | 100 | | 125 | | 150 | ns |
| | | 4.5 | | | 9 | 20 | | 25 | | 30 | |
| | | 6.0 | | | 7 | 17 | | 21 | | 26 | |
| $t_{W(L)}$ | Minimum Pulse Width (LOAD) | 2.0 | | | 34 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 9 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 7 | 13 | | 16 | | 19 | |
| $t_{W(H)}$ | Minimum Pulse Width (CLEAR) | 2.0 | | | 40 | 100 | | 125 | | 150 | ns |
| | | 4.5 | | | 12 | 20 | | 25 | | 30 | |
| | | 6.0 | | | 10 | 17 | | 21 | | 26 | |
| $t_s$ | Minimum Set-up Time(DATA -LOAD) | 2.0 | | | 30 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 9 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 7 | 13 | | 16 | | 19 | |
| $t_h$ | Minimum Hold Time | 2.0 | | | | 0 | | 0 | | 0 | ns |
| | | 4.5 | | | | 0 | | 0 | | 0 | |
| | | 6.0 | | | | 0 | | 0 | | 0 | |
| $t_{REM}$ | Minimum Removal Time (LOAD) | 2.0 | | | 6 | 50 | | 65 | | 75 | ns |
| | | 4.5 | | | 2 | 10 | | 13 | | 15 | |
| | | 6.0 | | | 2 | 9 | | 11 | | 13 | |
| $t_{REM}$ | Minimum Removal Time (CLEAR) | 2.0 | | | 14 | 50 | | 65 | | 75 | ns |
| | | 4.5 | | | 4 | 10 | | 13 | | 15 | |
| | | 6.0 | | | 3 | 9 | | 11 | | 13 | |

## CAPACITIVE CHARACTERISTICS

| Symbol | Parameter | Test Condition | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (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 | | | 68 | | | | | | 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. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

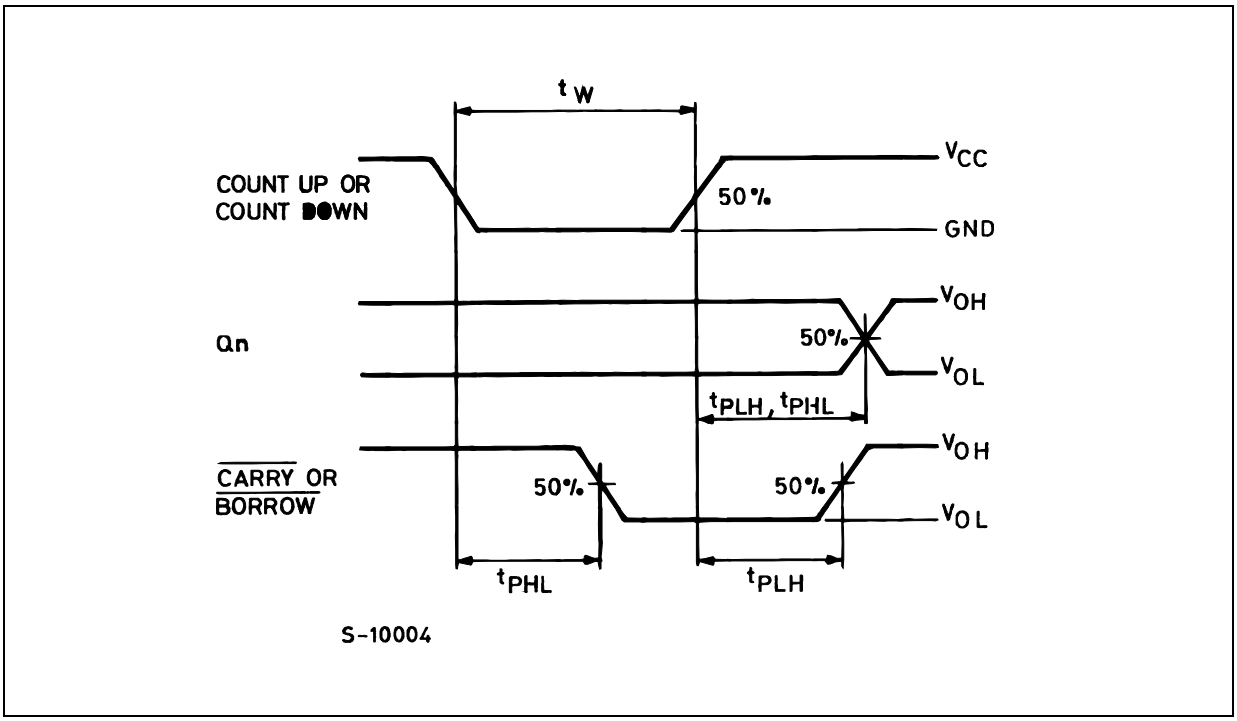
## TEST CIRCUIT



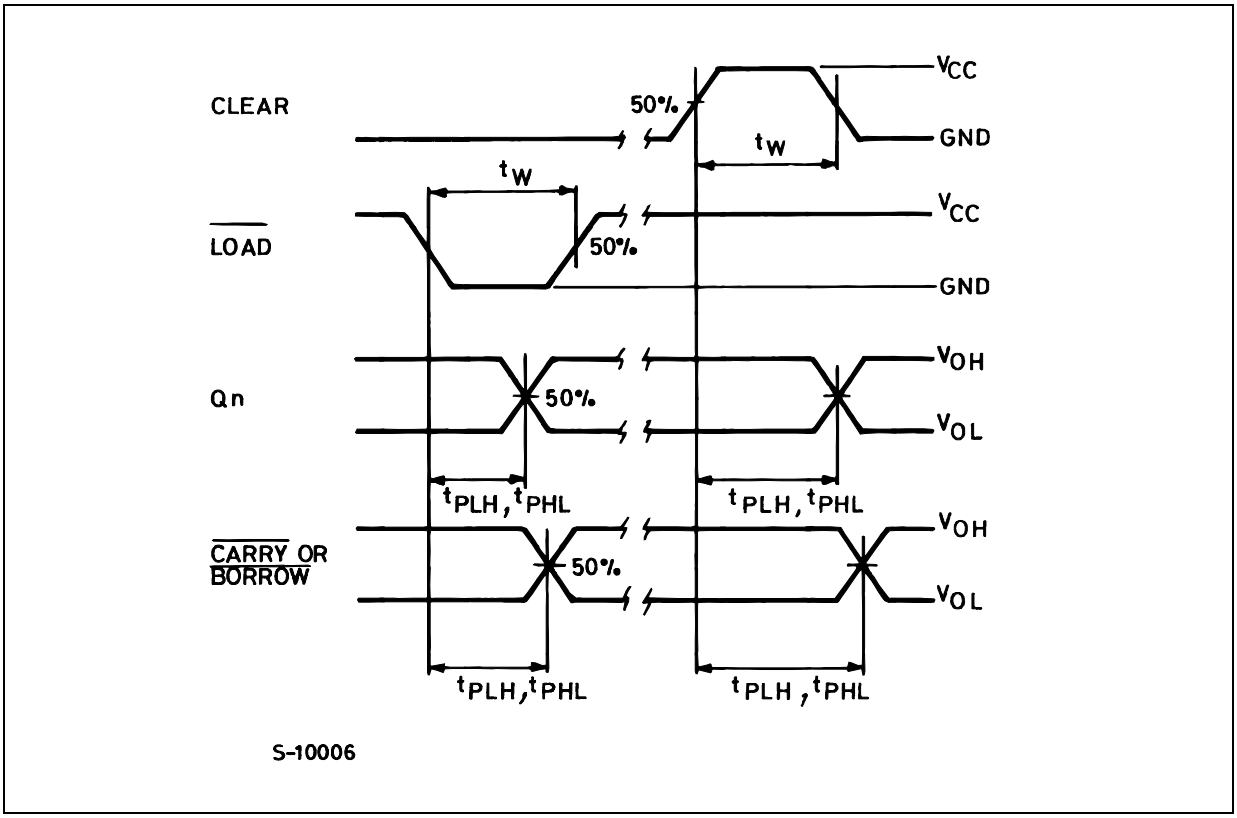

$C_L$ = 50pF or equivalent (includes jig and probe capacitance)
$R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

## WAVEFORM 1 : PROPAGATION DELAY TIME, MINIMUM PULSE WIDTH (COUNT UP AND DOWN)

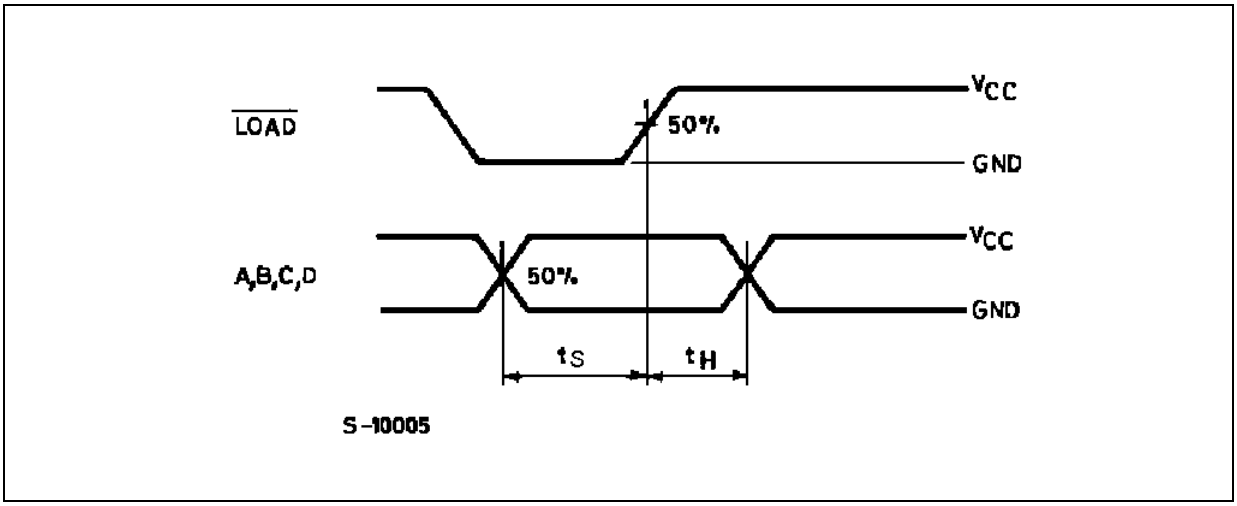
(f=1MHz; 50% duty cycle)



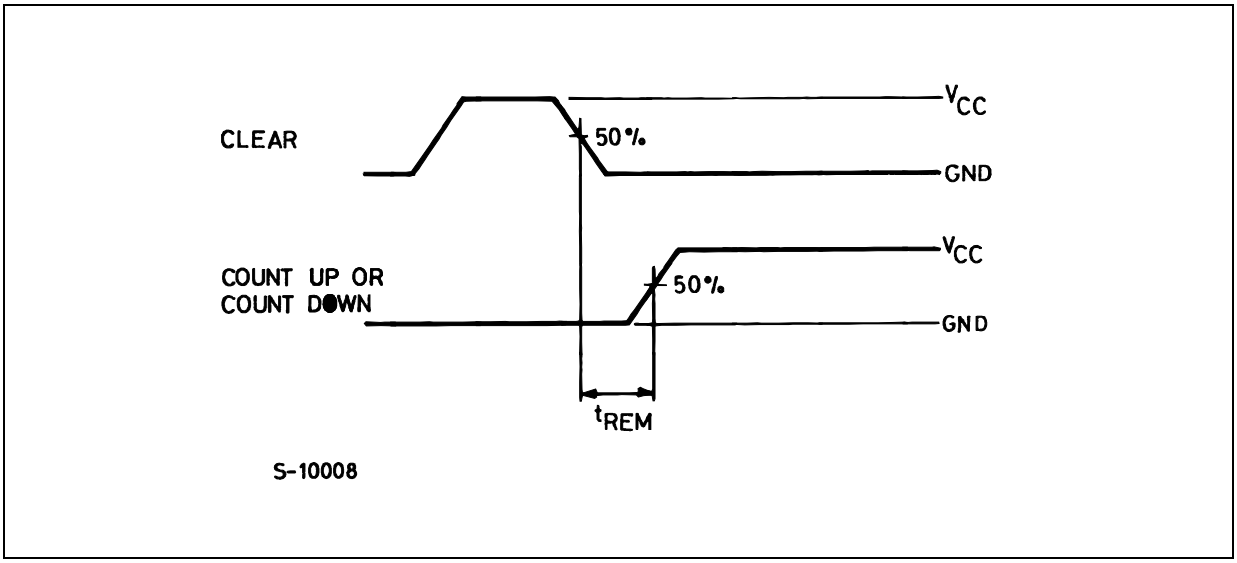
**WAVEFORM 2 : PROPAGATION DELAY TIME, MINIMUM PULSE WIDTH (CLEAR, $\overline{\text{LOAD}}$)**
(f=1MHz; 50% duty cycle)



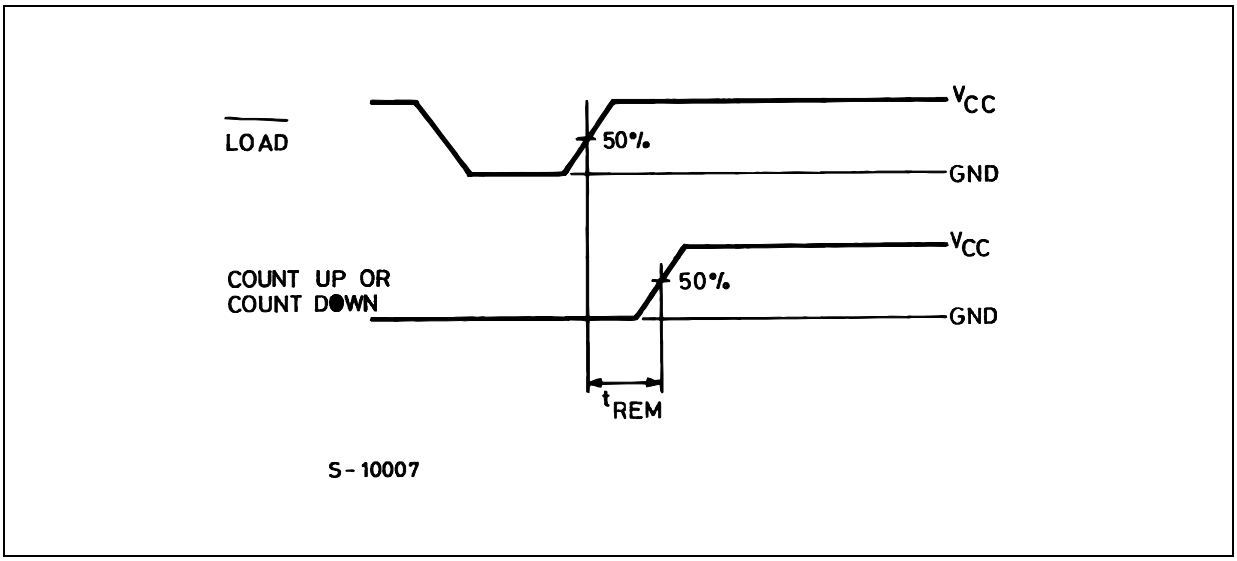

**WAVEFORM 3 : SETUP AND HOLD TIME (A, B, C, D to $\overline{\text{LOAD}}$)** (f=1MHz; 50% duty cycle)



**WAVEFORM 4: MINIMUM REMOVAL TIME (COUNT UP OR DOWN TO CLEAR)**
(f=1MHz; 50% duty cycle)

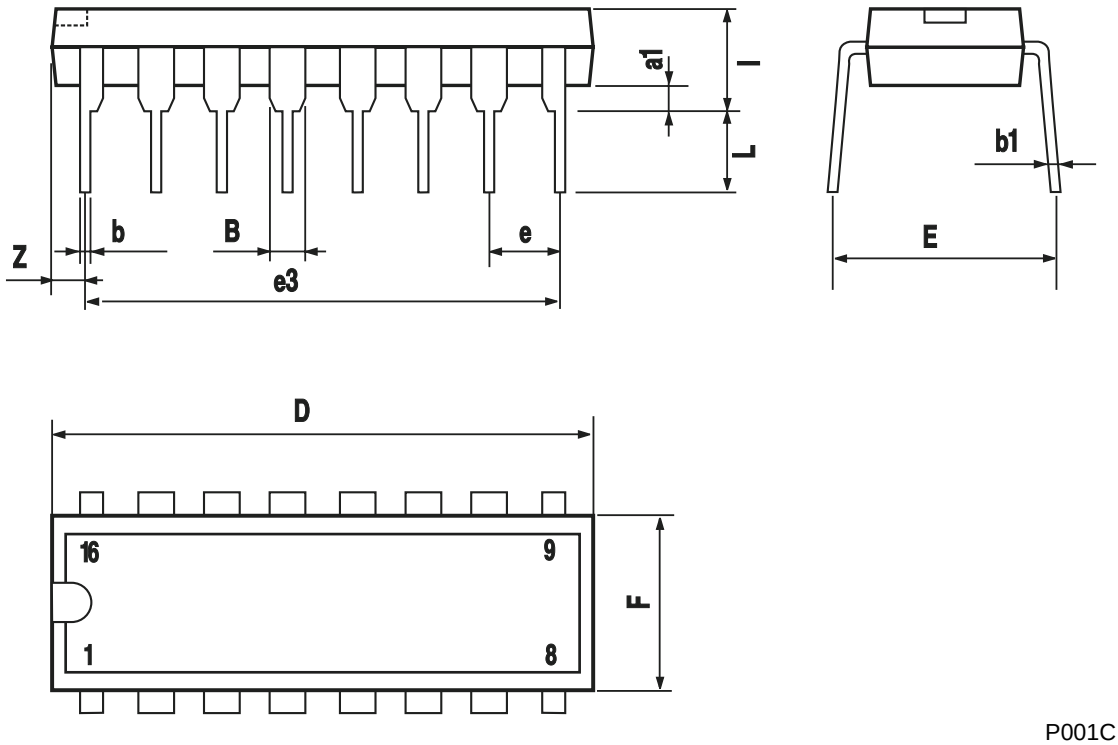



**WAVEFORM 5 : MINIMUM REMOVAL TIME (COUNT UP OR DOWN TO $\overline{\text{LOAD}}$)**
(f=1MHz; 50% duty cycle)



## Plastic DIP-16 (0.25) MECHANICAL DATA

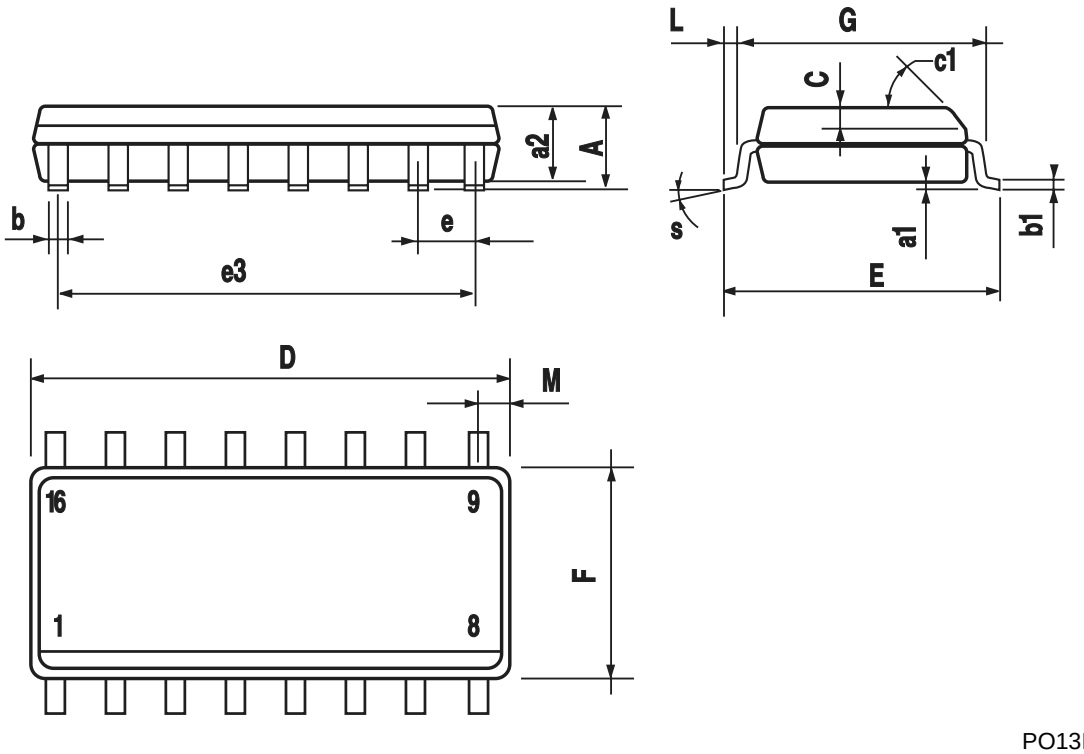
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 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

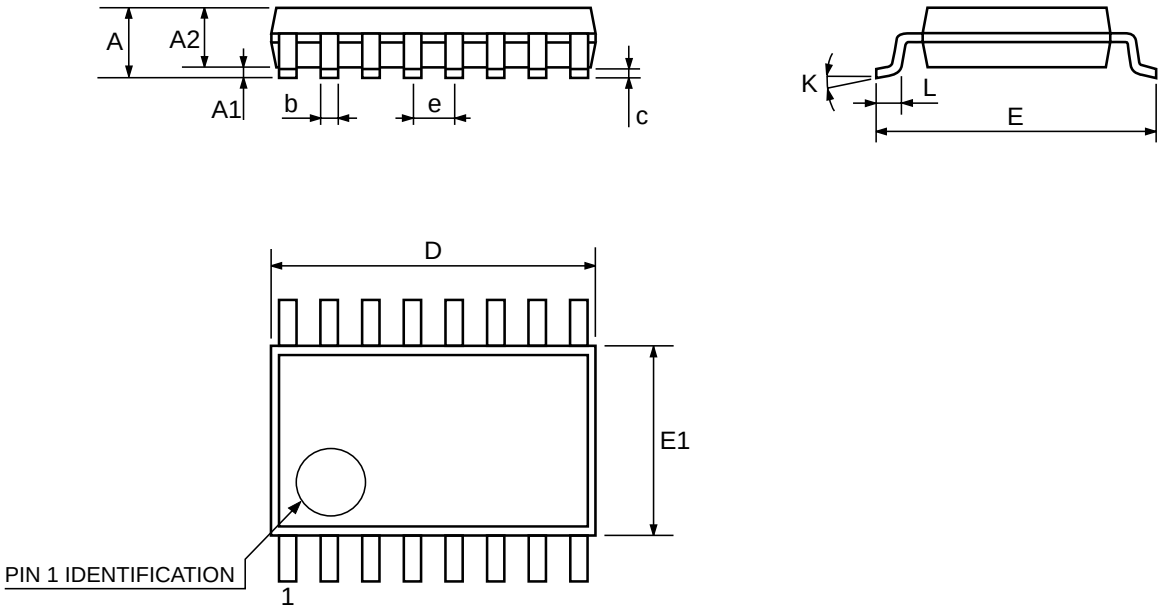
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.2 | 0.003 | | 0.007 |
| a2 | | | 1.65 | | | 0.064 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 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 |



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