

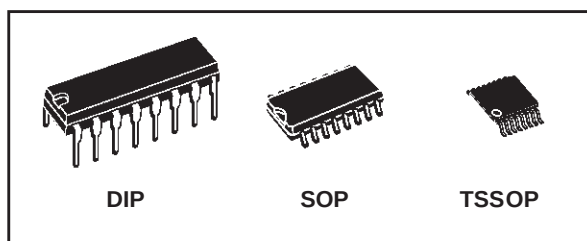
## SYNCHRONOUS PRESETTABLE 4-BIT COUNTER

- HIGH SPEED:  
 $f_{MAX} = 350\text{MHz}$  (TYP.) at  $V_{CC} = 5\text{V}$
- LOW POWER DISSIPATION:  
 $I_{CC} = 8\mu\text{A}$  (MAX.) at  $T_A = 25^\circ\text{C}$
- HIGH NOISE IMMUNITY:  
 $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (MIN.)
- 50Ω TRANSMISSION LINE DRIVING CAPABILITY
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OH}| = I_{OL} = 24\text{mA}$  (MIN)
- BALANCED PROPAGATION DELAYS:  
 $t_{PLH} \approx t_{PHL}$
- OPERATING VOLTAGE RANGE:  
 $V_{CC}$  (OPR) = 2V to 6V
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 161
- IMPROVED LATCH-UP IMMUNITY

### DESCRIPTION

The 74AC161 is an advanced high-speed CMOS SYNCHRONOUS PRESETTABLE COUNTER fabricated with sub-micron silicon gate and double-layer metal wiring C<sup>2</sup>MOS technology. It is a 4 bit binary counter with Asynchronous Clear.

The circuit have four fundamental modes of operation, in order of preference: synchronous reset, parallel load, count-up and hold. Four control inputs, (CLEAR), (LOAD), (PE) and (TE), determine the mode of operation as shown in the Truth Table. A LOW signal on CLEAR overrides



### ORDER CODES

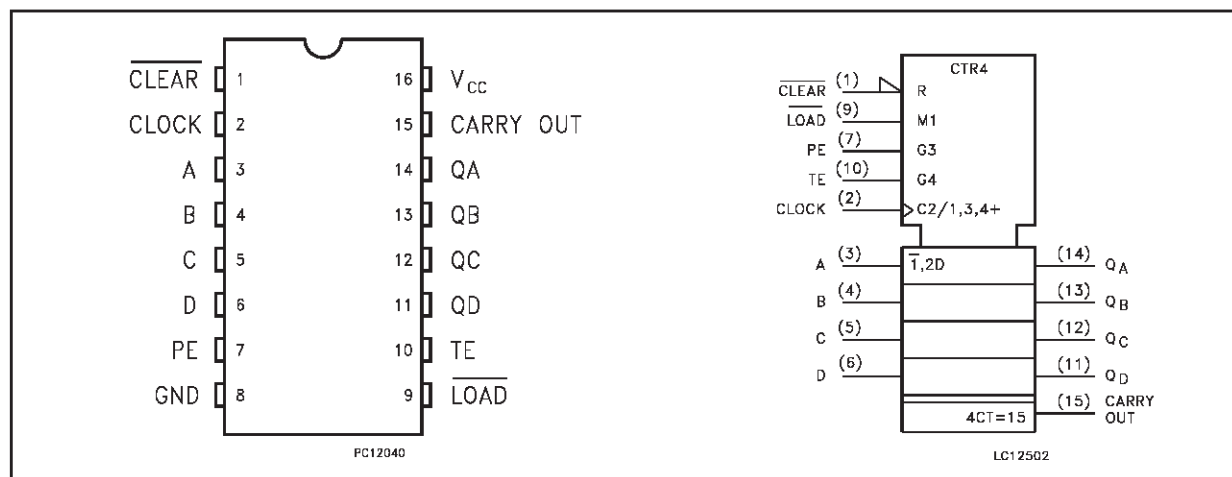
| PACKAGE | TUBE     | T & R      |
|---------|----------|------------|
| DIP     | 74AC161B |            |
| SOP     | 74AC161M | 74AC161MTR |
| TSSOP   |          | 74AC161TTR |

counting and parallel loading and sets all outputs on LOW state. A LOW signal on LOAD overrides counting and allows information on Parallel Data inputs to be loaded into the flip-flop on the next rising edge of CLOCK. With LOAD and CLEAR HIGH, PE and TE permit counting when both are HIGH. Conversely, a LOW signal on either PE and TE inhibits counting.

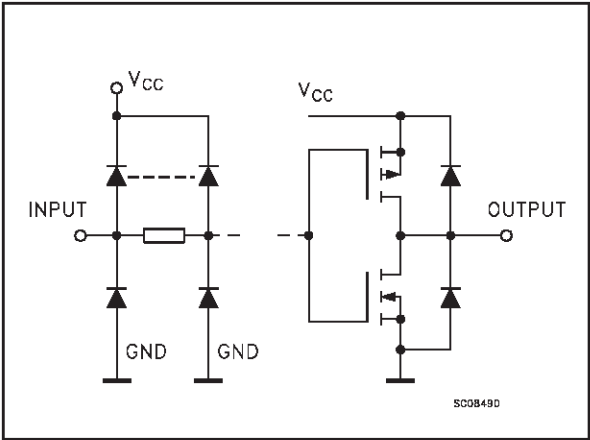
The CARRY OUTPUT is HIGH when TE is HIGH and counter is in state 15.

All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.

### PIN CONNECTION AND IEC LOGIC SYMBOLS



INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

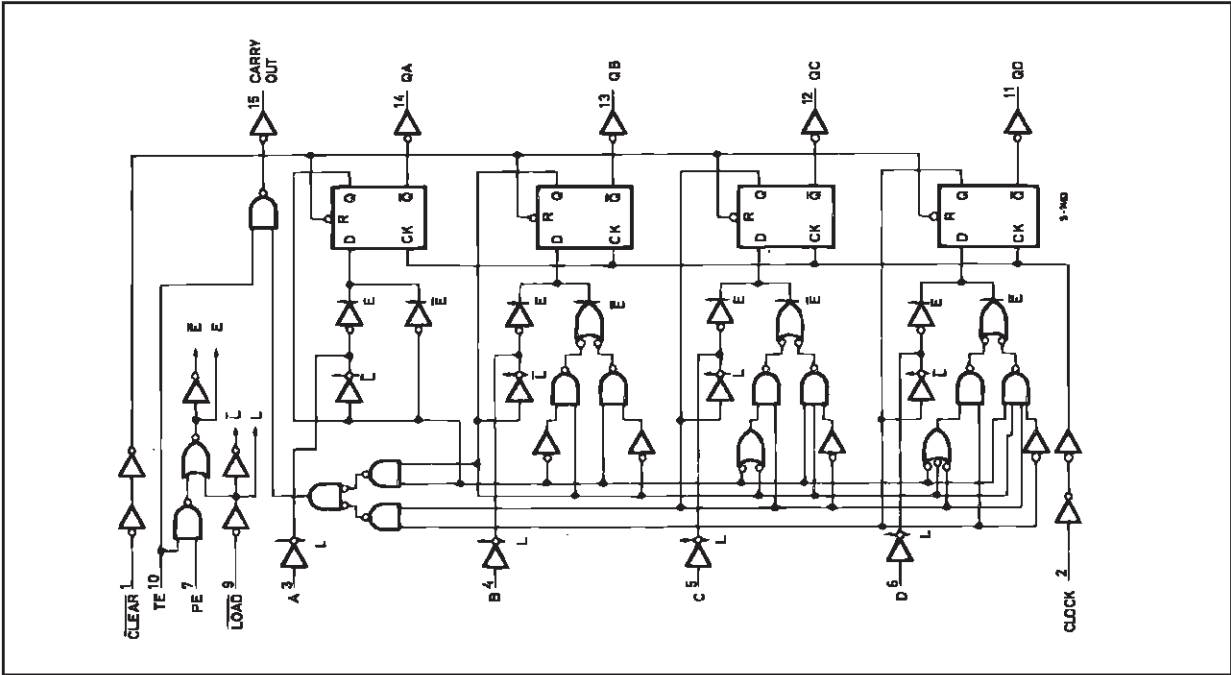
| PIN No         | SYMBOL          | NAME AND FUNCTION                      |
|----------------|-----------------|----------------------------------------|
| 1              | CLEAR           | Master Reset                           |
| 2              | CLOCK           | Clock Input (LOW to HIGH Edge Trigger) |
| 3, 4, 5, 6     | A, B, C, D      | Data Inputs                            |
| 7              | PE              | Count Enable Input                     |
| 10             | TE              | Count Enable Carry Input               |
| 9              | LOAD            | Parallel Enable Input                  |
| 14, 13, 12, 11 | QA to QD        | Flip-Flop Outputs                      |
| 15             | CARRY OUT       | Terminal Count Output                  |
| 8              | GND             | Ground (0V)                            |
| 16             | V <sub>CC</sub> | Positive Supply Voltage                |

TRUTH TABLE

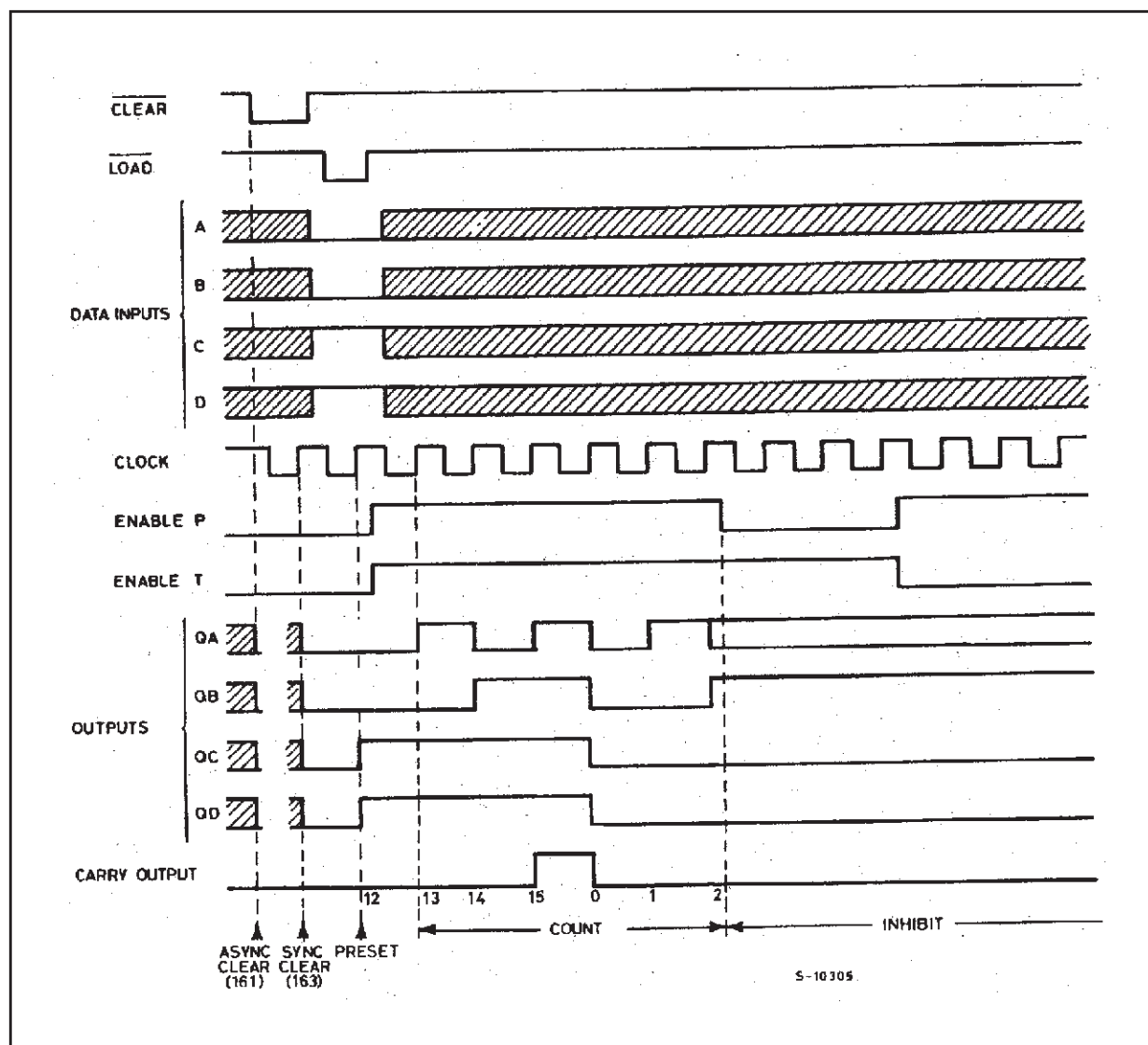
| INPUTS |      |    |    |    | OUTPUTS   |   |   |   | FUNCTION      |
|--------|------|----|----|----|-----------|---|---|---|---------------|
| CLEAR  | LOAD | PE | TE | CK |           |   |   |   |               |
| L      | X    | X  | X  | X  | L         | L | L | L | PRESET TO "0" |
| H      | L    | X  | X  |    | A         | B | C | D | PRESET DATA   |
| H      | H    | X  | L  |    | NO CHANGE |   |   |   | NO COUNT      |
| H      | H    | L  | X  |    | NO CHANGE |   |   |   | NO COUNT      |
| H      | H    | H  | H  |    | COUNT UP  |   |   |   | COUNT         |
| H      | X    | X  | X  |    | NO CHANGE |   |   |   | NO COUNT      |

X : Don't Care; A, B, C, D; Logic level of data input; CARRY OUT : TE x QA x QB x QC x QD

LOGIC DIAGRAM



## 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             | $\pm 50$               | mA   |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | $\pm 300$              | mA   |
| $T_{stg}$             | 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.

## 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   |
| dt/dv    | Input Rise and Fall Time $V_{CC} = 3.0, 4.5$ or $5.5V$ (note 1) | 8             | ns/V |

1)  $V_{IN}$  from 30% to 70% of  $V_{CC}$

## 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      | 3.0                    | V <sub>O</sub> = 0.1 V or<br>V <sub>CC</sub> -0.1V | 2.1                   | 1.5   |       | 2.1         |      | 2.1          |      | V    |
|                  |                               | 4.5                    |                                                    | 3.15                  | 2.25  |       | 3.15        |      | 3.15         |      |      |
|                  |                               | 5.5                    |                                                    | 3.85                  | 2.75  |       | 3.85        |      | 3.85         |      |      |
| V <sub>IL</sub>  | Low Level Input Voltage       | 3.0                    | V <sub>O</sub> = 0.1 V or<br>V <sub>CC</sub> -0.1V |                       | 1.5   | 0.9   |             | 0.9  |              | 0.9  | V    |
|                  |                               | 4.5                    |                                                    |                       | 2.25  | 1.35  |             | 1.35 |              | 1.35 |      |
|                  |                               | 5.5                    |                                                    |                       | 2.75  | 1.65  |             | 1.65 |              | 1.65 |      |
| V <sub>OH</sub>  | High Level Output Voltage     | 3.0                    | I <sub>O</sub> =-50 μA                             | 2.9                   | 2.99  |       | 2.9         |      | 2.9          |      | V    |
|                  |                               | 4.5                    | I <sub>O</sub> =-50 μA                             | 4.4                   | 4.49  |       | 4.4         |      | 4.4          |      |      |
|                  |                               | 5.5                    | I <sub>O</sub> =-50 μA                             | 5.4                   | 5.49  |       | 5.4         |      | 5.4          |      |      |
|                  |                               | 3.0                    | I <sub>O</sub> =-12 mA                             | 2.56                  |       |       | 2.46        |      | 2.4          |      |      |
|                  |                               | 4.5                    | I <sub>O</sub> =-24 mA                             | 3.86                  |       |       | 3.76        |      | 3.7          |      |      |
|                  |                               | 5.5                    | I <sub>O</sub> =-24 mA                             | 4.86                  |       |       | 4.76        |      | 4.7          |      |      |
| V <sub>OL</sub>  | Low Level Output Voltage      | 3.0                    | I <sub>O</sub> =50 μA                              |                       | 0.002 | 0.1   |             | 0.1  |              | 0.1  | V    |
|                  |                               | 4.5                    | I <sub>O</sub> =50 μA                              |                       | 0.001 | 0.1   |             | 0.1  |              | 0.1  |      |
|                  |                               | 5.5                    | I <sub>O</sub> =50 μA                              |                       | 0.001 | 0.1   |             | 0.1  |              | 0.1  |      |
|                  |                               | 3.0                    | I <sub>O</sub> =12 mA                              |                       |       | 0.36  |             | 0.44 |              | 0.5  |      |
|                  |                               | 4.5                    | I <sub>O</sub> =24 mA                              |                       |       | 0.36  |             | 0.44 |              | 0.5  |      |
|                  |                               | 5.5                    | I <sub>O</sub> =24 mA                              |                       |       | 0.36  |             | 0.44 |              | 0.5  |      |
| I <sub>I</sub>   | Input Leakage Current         | 5.5                    | V <sub>I</sub> = V <sub>CC</sub> or GND            |                       |       | ± 0.1 |             | ± 1  |              | ± 1  | μA   |
| I <sub>CC</sub>  | Quiescent Supply Current      | 5.5                    | V <sub>I</sub> = V <sub>CC</sub> or GND            |                       |       | 8     |             | 80   |              | 160  | μA   |
| I <sub>OLD</sub> | Dynamic Output Current        | 5.5                    | V <sub>OLD</sub> = 1.65 V max                      |                       |       |       |             | 75   |              | 50   | mA   |
| I <sub>OHD</sub> | V <sub>OHD</sub> = 3.85 V min |                        |                                                    |                       |       |       | -75         |      | -50          | mA   |      |

1) Maximum test duration 2ms, one output loaded at time

2) Incident wave switching is guaranteed on transmission lines with impedances as low as 50Ω

AC ELECTRICAL CHARACTERISTICS ( $C_L = 50 \text{ pF}$ ,  $R_L = 500 \Omega$ , Input  $t_r = t_f = 3 \text{ ns}$ )

| 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>PLH</sub> t <sub>PHL</sub> | Propagation Delay Time CLOCK to Q          | 3.3 <sup>(*)</sup>     |  |                       | 7.0  | 12.0 |             | 13.0 |              | 13.0 | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | 5.0  | 9.0  |             | 10.0 |              | 10.0 |      |
| t <sub>PLH</sub> t <sub>PHL</sub> | Propagation Delay Time CLOCK to CARRY OUT  | 3.3 <sup>(*)</sup>     |  |                       | 8.5  | 14.0 |             | 15.0 |              | 15.0 | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | 6.0  | 10.0 |             | 11.0 |              | 11.0 |      |
| t <sub>PLH</sub> t <sub>PHL</sub> | Propagation Delay Time TE to CARRY OUT     | 3.3 <sup>(*)</sup>     |  |                       | 5.5  | 9.5  |             | 11.0 |              | 11.0 | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | 3.5  | 6.5  |             | 7.5  |              | 7.5  |      |
| t <sub>PHL</sub>                  | Propagation Delay Time CLEAR to Q          | 3.3 <sup>(*)</sup>     |  |                       | 6.5  | 12.0 |             | 13.0 |              | 13.0 | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | 5.5  | 9.0  |             | 10.0 |              | 10.0 |      |
| t <sub>PHL</sub>                  | Propagation Delay Time CLEAR to CARRY OUT  | 3.3 <sup>(*)</sup>     |  |                       | 7.0  | 12.0 |             | 13.0 |              | 13.0 | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | 5.5  | 9.5  |             | 10.0 |              | 10.0 |      |
| t <sub>WL</sub>                   | CLEAR Pulse Width LOW                      | 3.3 <sup>(*)</sup>     |  |                       | 3.0  | 5.5  |             | 7.5  |              | 7.5  | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | 2.5  | 4.5  |             | 6.0  |              | 6.0  |      |
| t <sub>W</sub>                    | CLOCK Pulse Width HIGH or LOW              | 3.3 <sup>(*)</sup>     |  |                       | 2.0  | 3.5  |             | 4.0  |              | 4.0  | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | 2.0  | 3.0  |             | 3.5  |              | 3.5  |      |
| t <sub>s</sub>                    | Setup Time HIGH or LOW (INPUT to CLOCK)    | 3.3 <sup>(*)</sup>     |  |                       | 4.0  | 13.5 |             | 16.0 |              | 16.0 | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | 1.5  | 8.5  |             | 10.5 |              | 10.5 |      |
| t <sub>h</sub>                    | Hold Time HIGH or LOW (INPUT to CLOCK)     | 3.3 <sup>(*)</sup>     |  |                       | -1.0 | -1.0 |             | 0.5  |              | 0.5  | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | -0.5 | 0.5  |             | 1.0  |              | 1.0  |      |
| t <sub>s</sub>                    | Setup Time HIGH or LOW (CLEAR to CLOCK)    | 3.3 <sup>(*)</sup>     |  |                       | 3.0  | 11.5 |             | 14.0 |              | 14.0 | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | 2.0  | 7.5  |             | 8.5  |              | 8.5  |      |
| t <sub>h</sub>                    | Hold Time HIGH or LOW (CLEAR to CLOCK)     | 3.3 <sup>(*)</sup>     |  |                       | -2.5 | 0    |             | 0    |              | 0    | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | -2.0 | 0.5  |             | 1.0  |              | 1.0  |      |
| t <sub>s</sub>                    | Setup Time HIGH or LOW (PE or TE to CLOCK) | 3.3 <sup>(*)</sup>     |  |                       | 3.0  | 6.0  |             | 7.0  |              | 7.0  | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | 2.0  | 4.5  |             | 5.0  |              | 5.0  |      |
| t <sub>h</sub>                    | Hold Time HIGH or LOW (PE or TE to CLOCK)  | 3.3 <sup>(*)</sup>     |  |                       | -1.0 | 0    |             | 0    |              | 0    | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | -0.5 | 0    |             | 0.5  |              | 0.5  |      |
| t <sub>REM</sub>                  | Recovery Time (CLEAR to CLOCK)             | 3.3 <sup>(*)</sup>     |  |                       | -1.0 | 0    |             | 0.5  |              | 0.5  | ns   |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  |                       | -0.5 | 0.5  |             | 1.0  |              | 1.0  |      |
| f <sub>MAX</sub>                  | Maximum Clock Frequency                    | 3.3 <sup>(*)</sup>     |  | 70                    | 250  |      | 60          |      | 60           |      | MHz  |
|                                   |                                            | 5.0 <sup>(**)</sup>    |  | 110                   | 350  |      | 95          |      | 95           |      |      |

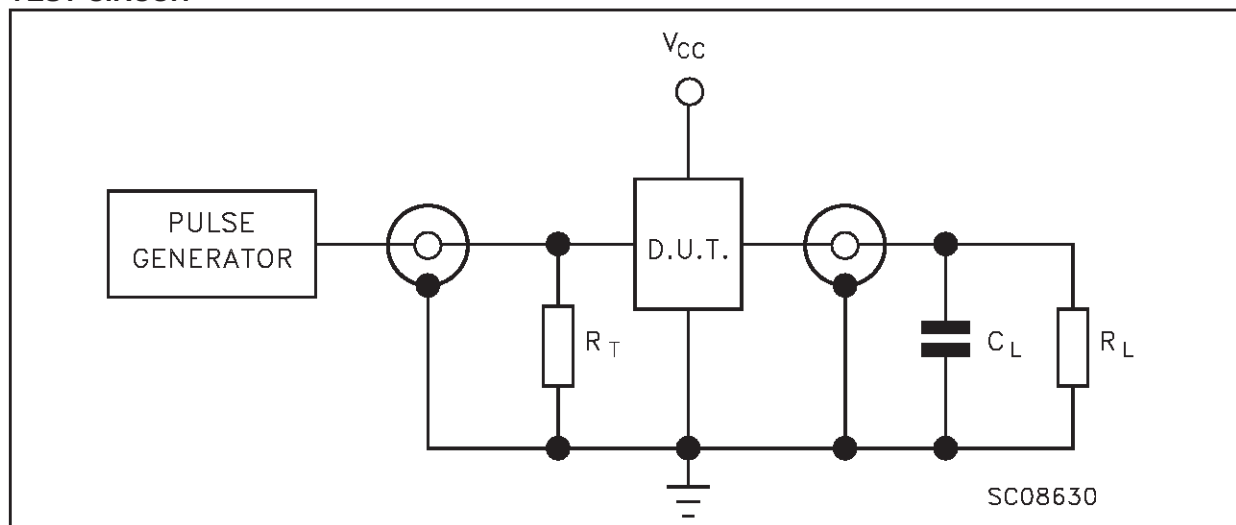
(\*) Voltage range is  $3.3\text{V} \pm 0.3\text{V}$ (\*\*) Voltage range is  $5.0\text{V} \pm 0.5\text{V}$

## CAPACITIVE CHARACTERISTICS

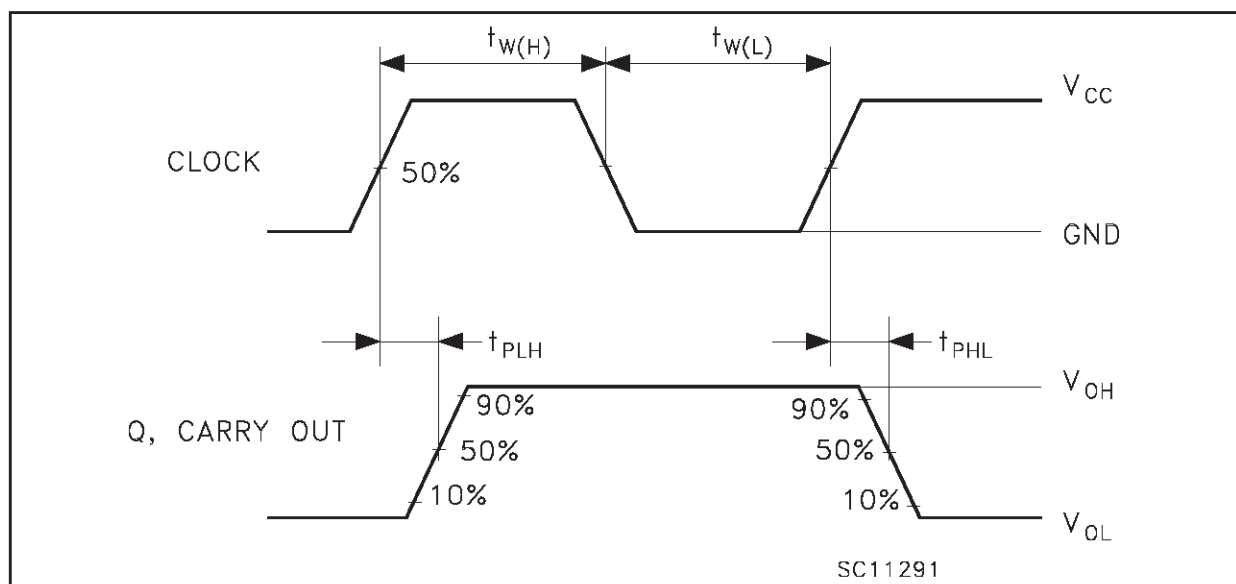
| Symbol          | Parameter                             | Test Condition         |                         | Value                 |      |      |             |      |              |      | Unit |
|-----------------|---------------------------------------|------------------------|-------------------------|-----------------------|------|------|-------------|------|--------------|------|------|
|                 |                                       | 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                    |                         |                       | 4.5  |      |             |      |              |      | pF   |
| C <sub>PD</sub> | Power Dissipation Capacitance (note1) | 5.0                    | f <sub>IN</sub> = 10MHz |                       | 18   |      |             |      |              |      | pF   |

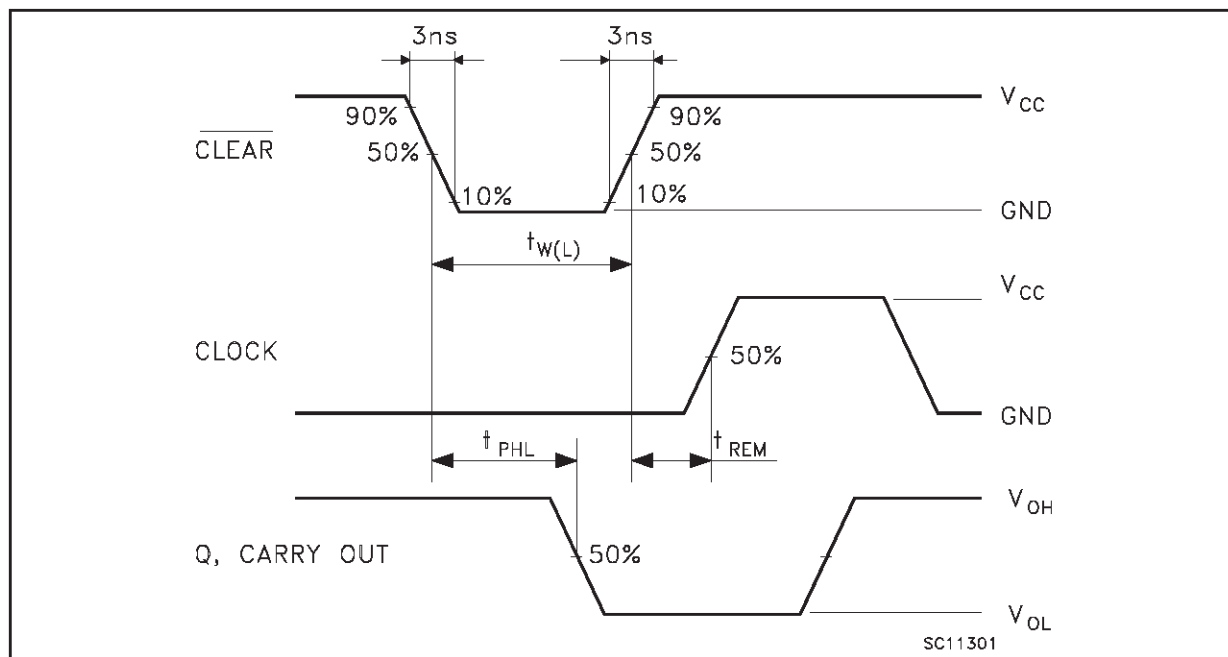
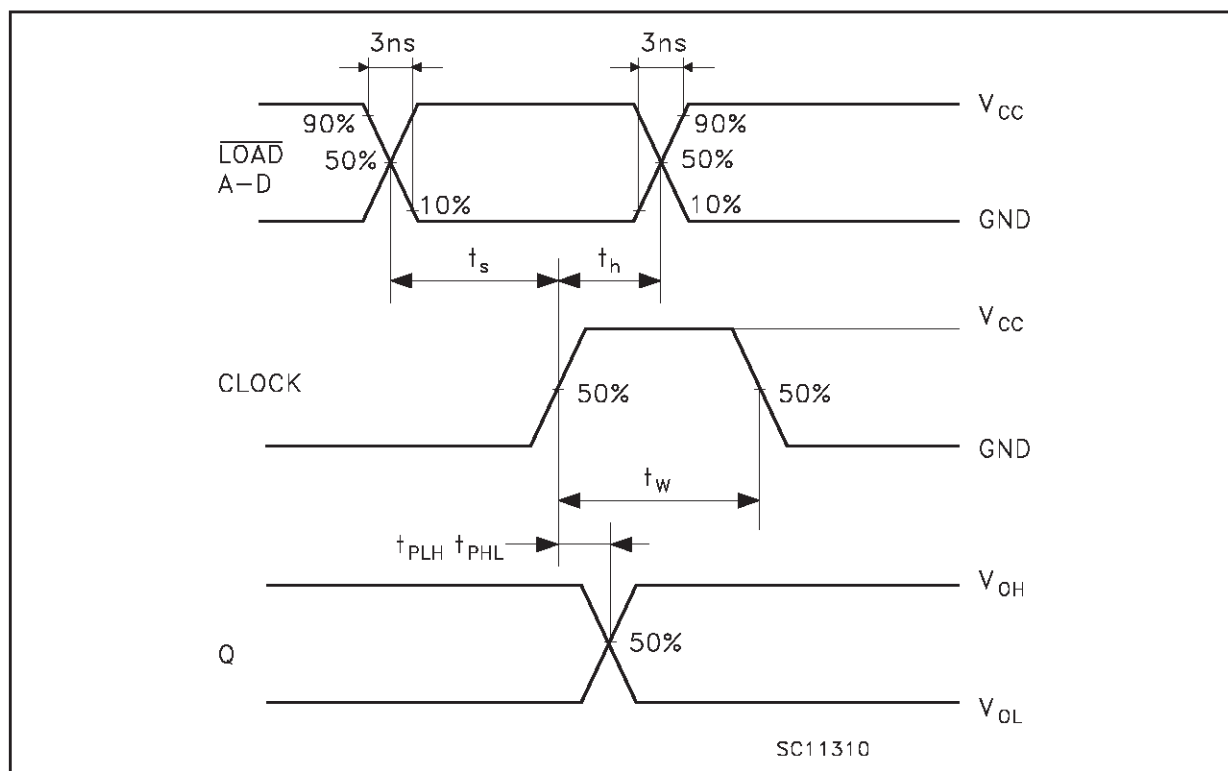
1)  $C_{PD}$  is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} +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

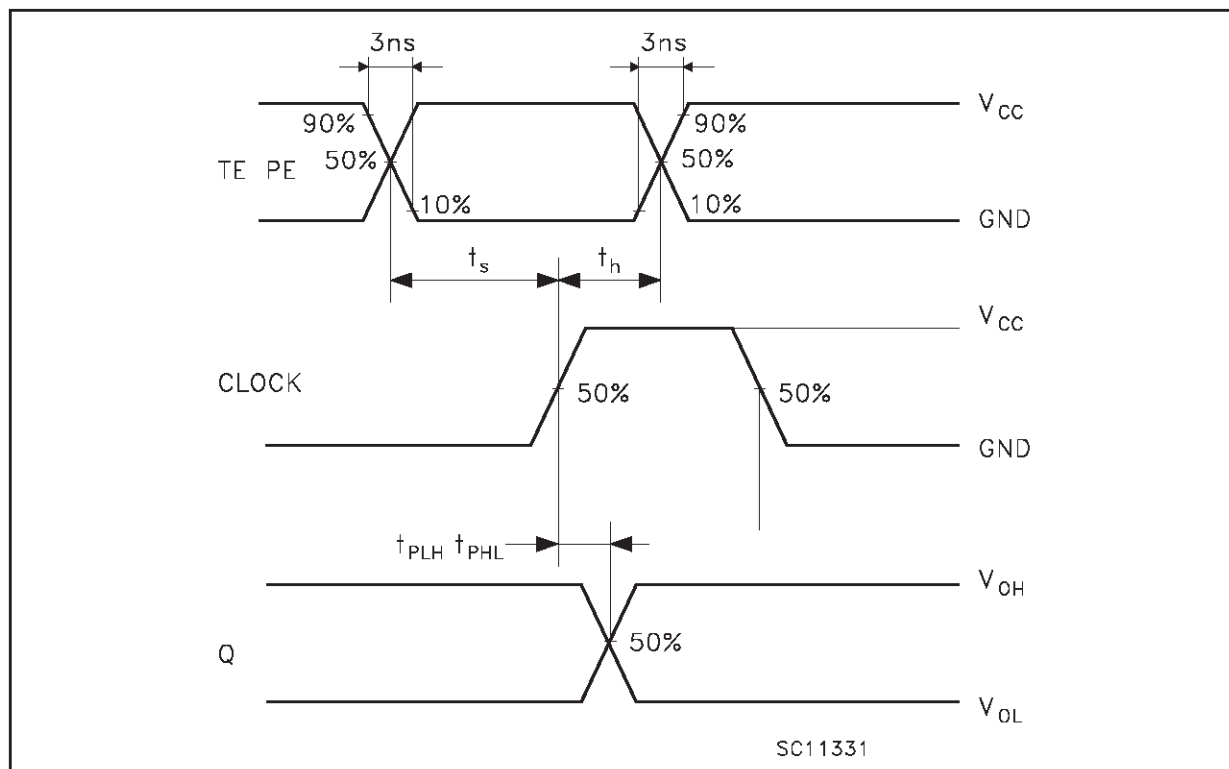
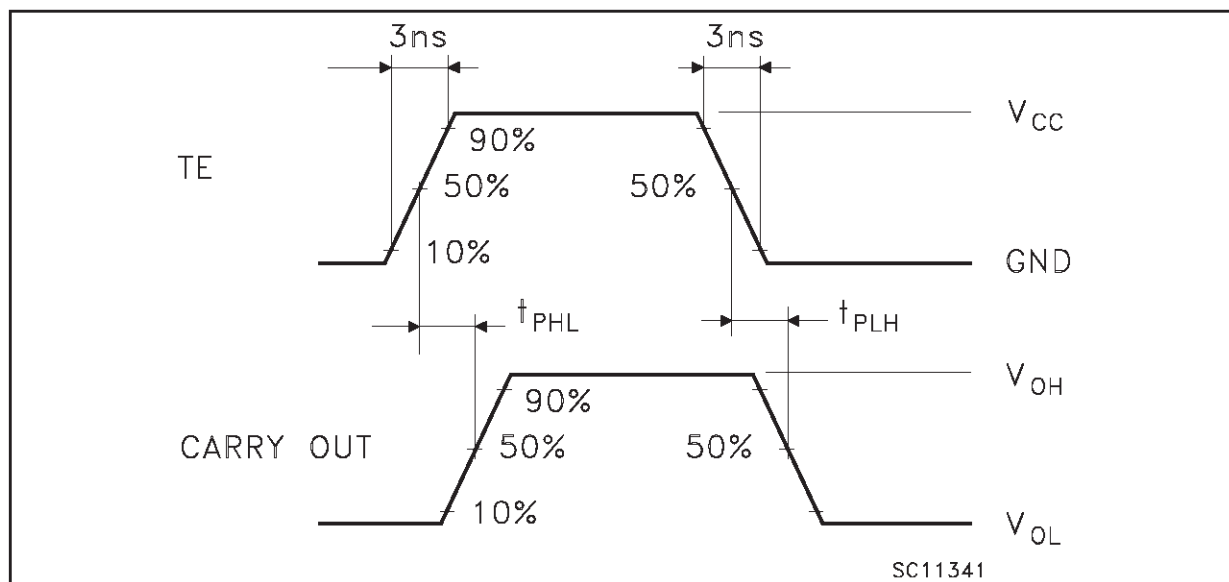
## TEST CIRCUIT



$C_L = 50\text{pF}$  or equivalent (includes jig and probe capacitance)  
 $R_L = R_1 = 500\Omega$  or equivalent  
 $R_T = Z_{OUT}$  of pulse generator (typically  $50\Omega$ )

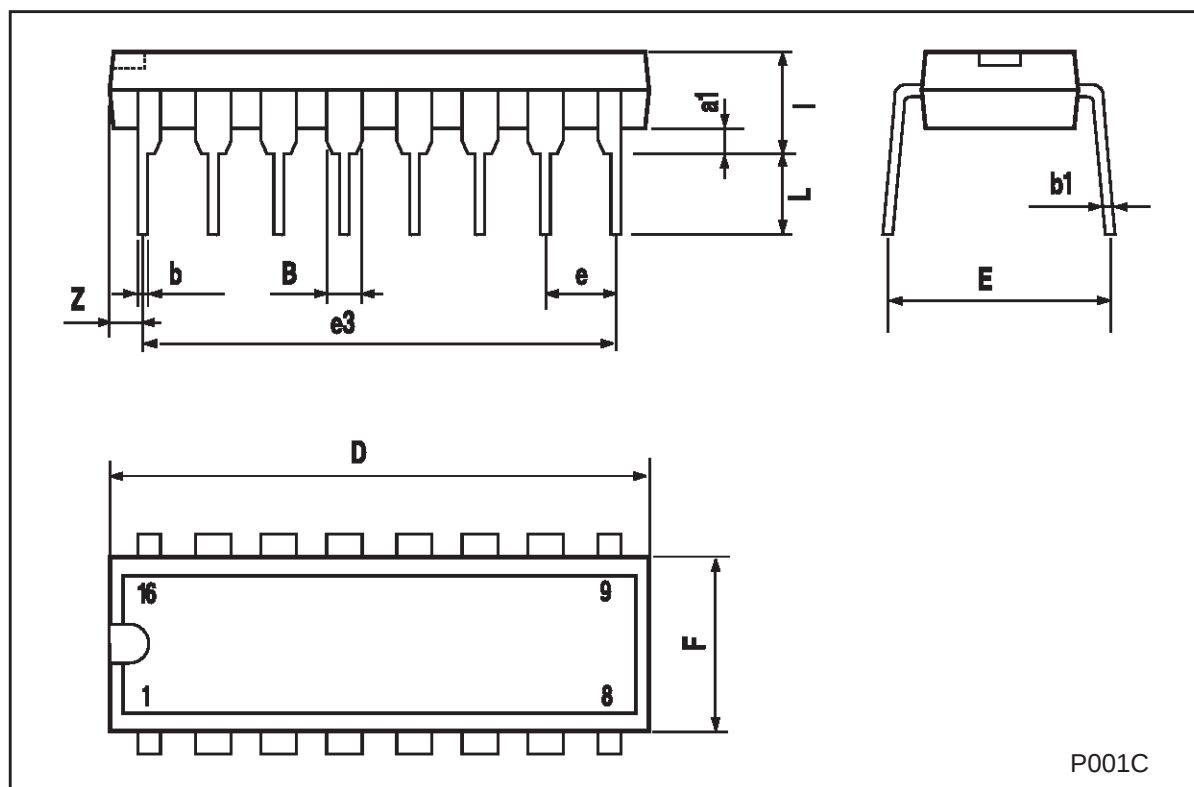
WAVEFORM 1: PROPAGATION DELAYS, COUNT MODE ( $f=1\text{MHz}$ ; 50% duty cycle)

**WAVEFORM 2: PROPAGATION DELAYS CLEAR MODE** ( $f=1\text{MHz}$ ; 50% duty cycle)**WAVEFORM 3: PROPAGATION DELAYS PRESET MODE** ( $f=1\text{MHz}$ ; 50% duty cycle)

**WAVEFORM 4: PROPAGATION DELAYS COUNTABLE MODE** ( $f=1\text{MHz}$ ; 50% duty cycle)**WAVEFORM 5: PROPAGATION DELAYS CASCADE MODE** ( $f=1\text{MHz}$ ; 50% duty cycle)

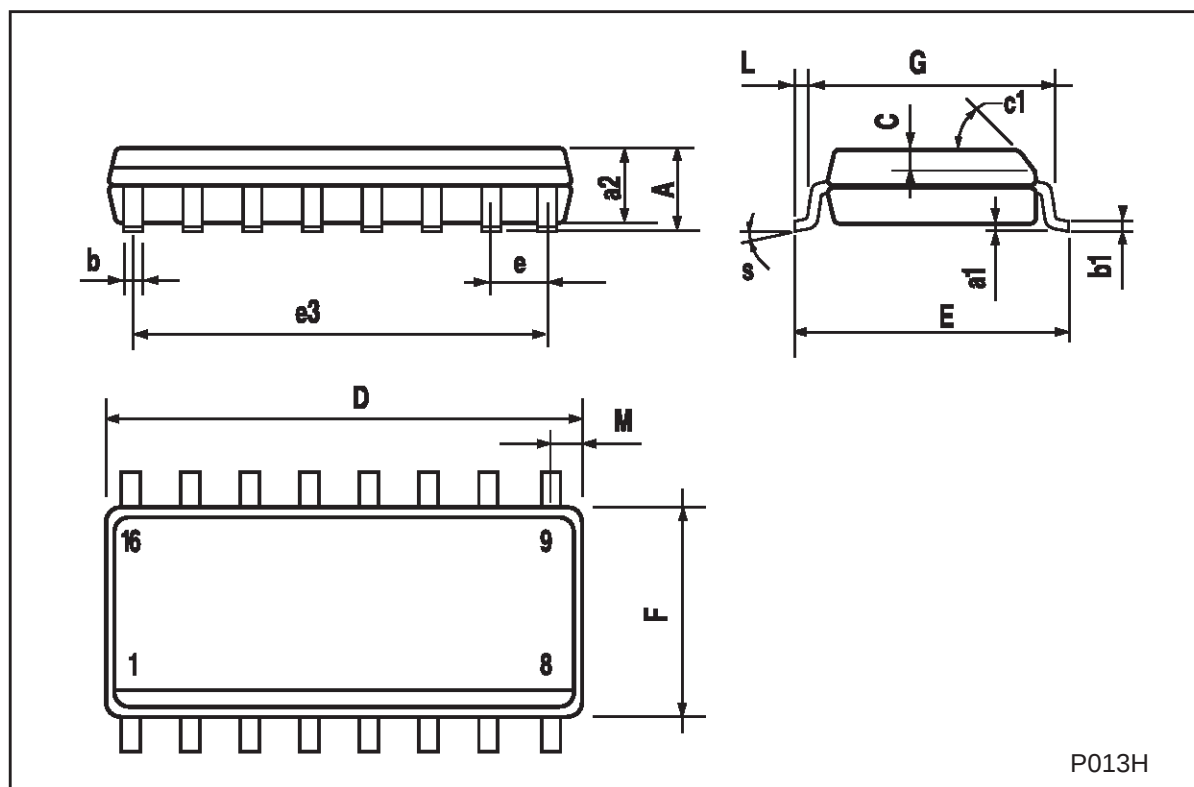
## Plastic DIP-16 (0.25) MECHANICAL DATA

| 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 |



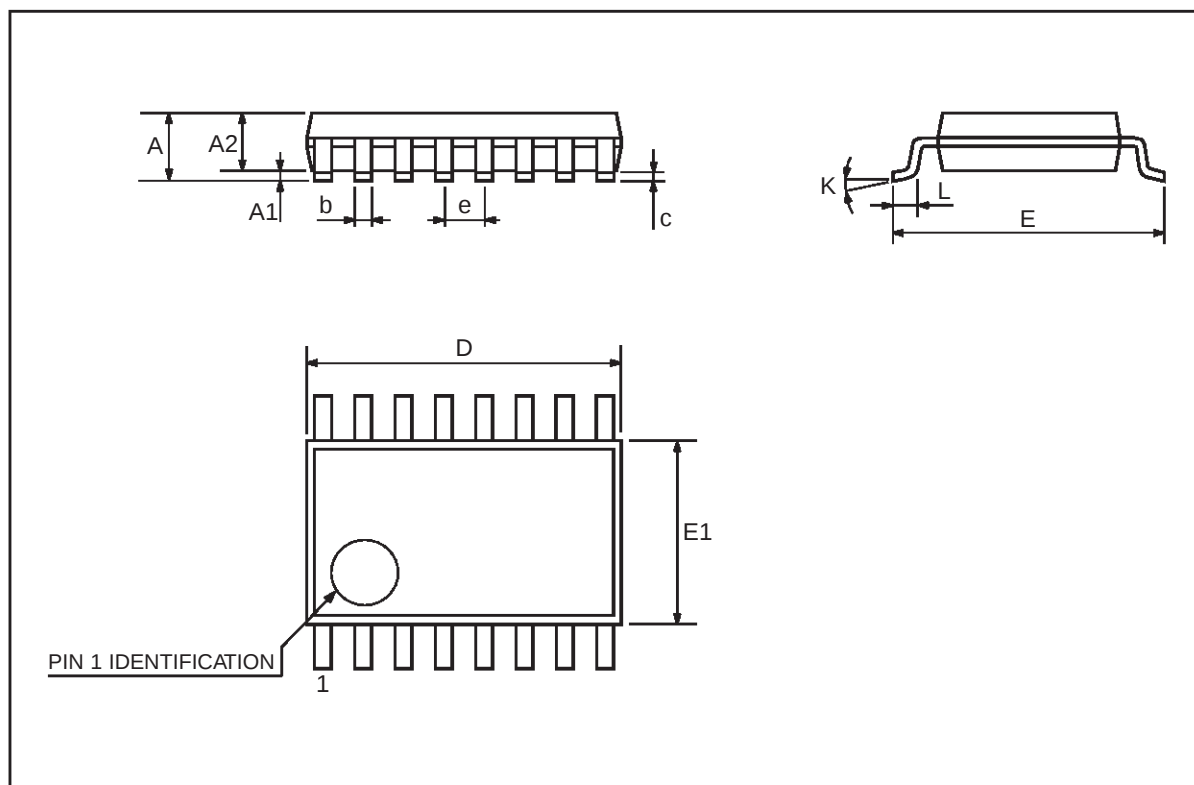
## SO-16 MECHANICAL DATA

| DIM. | mm        |      |      | inch  |       |       |
|------|-----------|------|------|-------|-------|-------|
|      | MIN.      | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |           |      | 1.75 |       |       | 0.068 |
| a1   | 0.1       |      | 0.2  | 0.004 |       | 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    |      |          | 1.1  |        |            | 0.433  |
| A1   | 0.05 | 0.10     | 0.15 | 0.002  | 0.004      | 0.006  |
| A2   | 0.85 | 0.9      | 0.95 | 0.335  | 0.354      | 0.374  |
| b    | 0.19 |          | 0.30 | 0.0075 |            | 0.0118 |
| c    | 0.09 |          | 0.20 | 0.0035 |            | 0.0079 |
| D    | 4.9  | 5        | 5.1  | 0.193  | 0.197      | 0.201  |
| E    | 6.25 | 6.4      | 6.5  | 0.246  | 0.252      | 0.256  |
| E1   | 4.3  | 4.4      | 4.48 | 0.169  | 0.173      | 0.176  |
| e    |      | 0.65 BSC |      |        | 0.0256 BSC |        |
| K    | 0°   | 4°       | 8°   | 0°     | 4°         | 8°     |
| L    | 0.50 | 0.60     | 0.70 | 0.020  | 0.024      | 0.028  |



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