

DUAL BINARY COUNTER

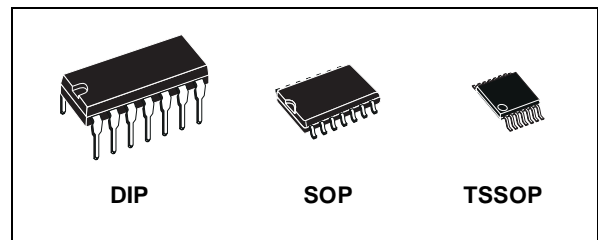
- HIGH SPEED :
 $f_{MAX} = 79 \text{ MHz (TYP.) at } V_{CC} = 6V$
- LOW POWER DISSIPATION:
 $I_{CC} = 4\mu A (MAX.) \text{ at } T_A = 25^\circ C$
- HIGH NOISE IMMUNITY:
 $V_{NIH} = V_{NIL} = 28 \% V_{CC} (MIN.)$
- SYMMETRICAL OUTPUT IMPEDANCE:
 $|I_{OH}| = I_{OL} = 4mA (MIN)$
- BALANCED PROPAGATION DELAYS:
 $t_{PLH} \cong t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE:
 $V_{CC} (OPR) = 2V \text{ to } 6V$
- PIN AND FUNCTION COMPATIBLE WITH
 74 SERIES 393

DESCRIPTION

The M74HC393 is an high speed CMOS DUAL BINARY COUNTER fabricated with silicon gate C²MOS technology.

This counter circuit contains independent ripple carry counters and two 4-bit ripple carry binary counters, which can be cascaded to create a single divide by 256 counter.

Each 4-bit counter is incremented on the high to low transition (negative edge) of the clock input,



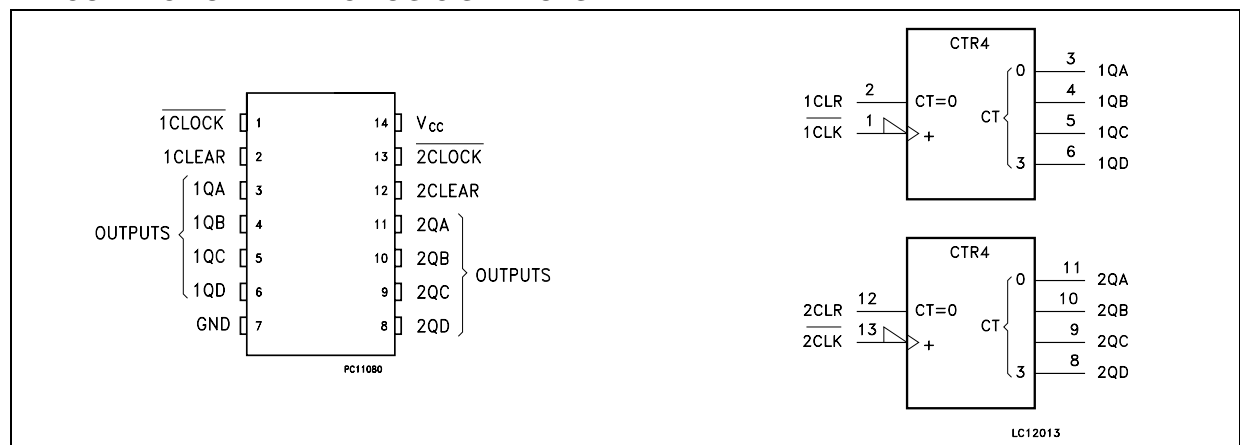
ORDER CODES

| PACKAGE | TUBE | T & R |
|---------|-------------|----------------|
| DIP | M74HC393B1R | |
| SOP | M74HC393M1R | M74HC393RM13TR |
| TSSOP | | M74HC393TTR |

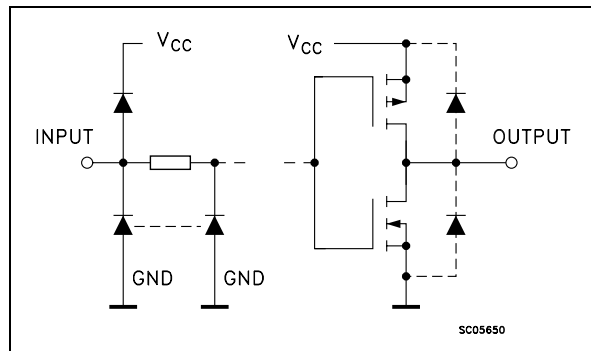
and each has an independent clear input. When CLEAR is set to low, all four bits of each counter are set to a low level. This enables count truncation and allows the implementation of divide by N counter configurations.

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, 13 | $\frac{1 \text{ CLOCK}}{2 \text{ CLOCK}}$ | Clock Input Divide by 2 Section (HIGH to LOW Edge-Triggered) |
| 2, 12 | 1 CLEAR 2 CLEAR | Asynchronous Master Reset Inputs |
| 3, 4, 5, 6 | 1QA to 1QD | Flip Flop Outputs |
| 11, 10, 9, 8 | 2QA to 2QD | Flip Flop Outputs |
| 7 | GND | Ground (0V) |
| 14 | Vcc | Positive Supply Voltage |

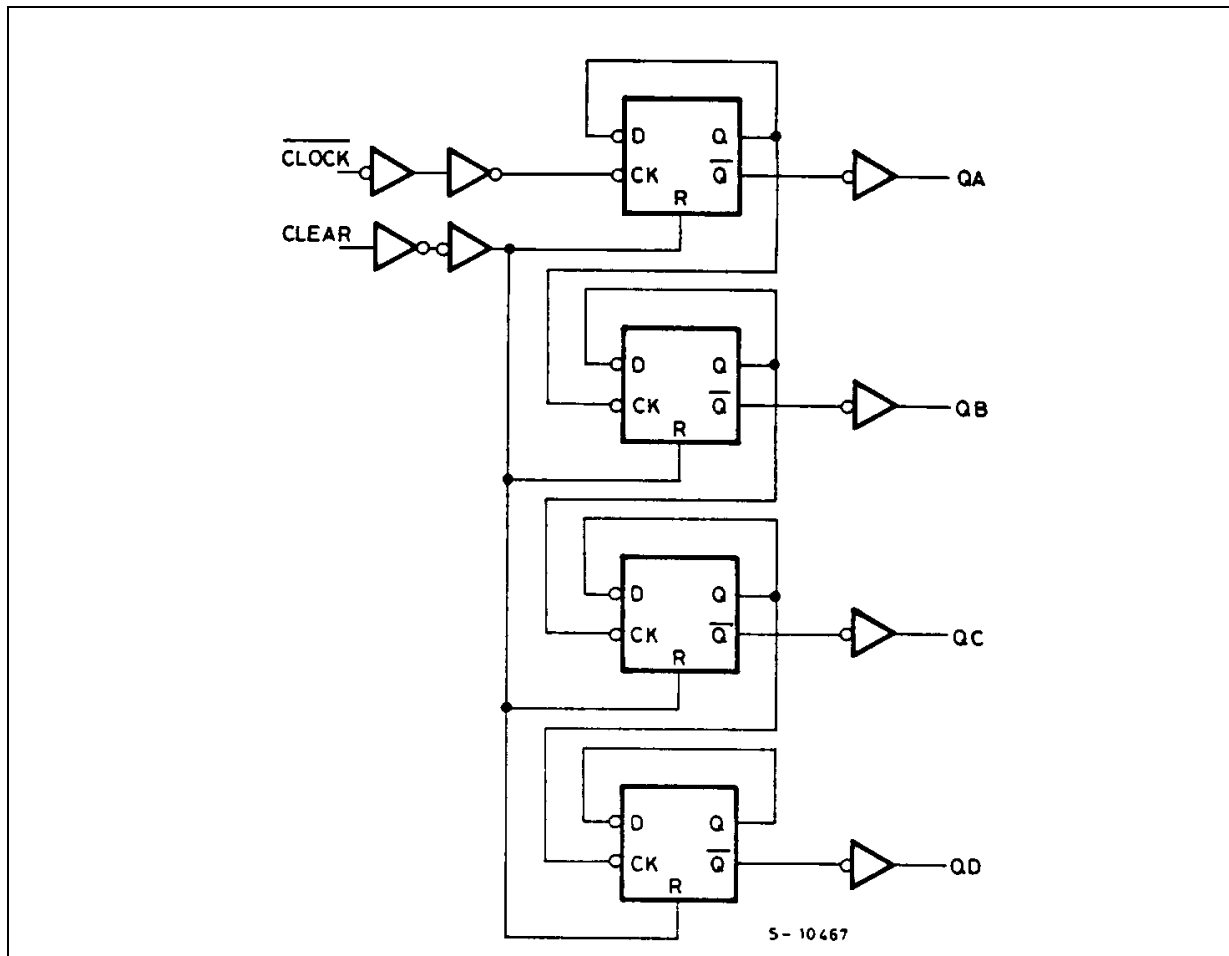
TRUTH TABLE

| INPUTS | | OUTPUTS | | | |
|---------------------------|-------|-----------|----|----|----|
| $\overline{\text{CLOCK}}$ | CLEAR | QD | QC | QB | QA |
| X | H | L | L | L | L |
| | L | COUNT UP | | | |
| | L | NO CHANGE | | | |

X : Don't Care

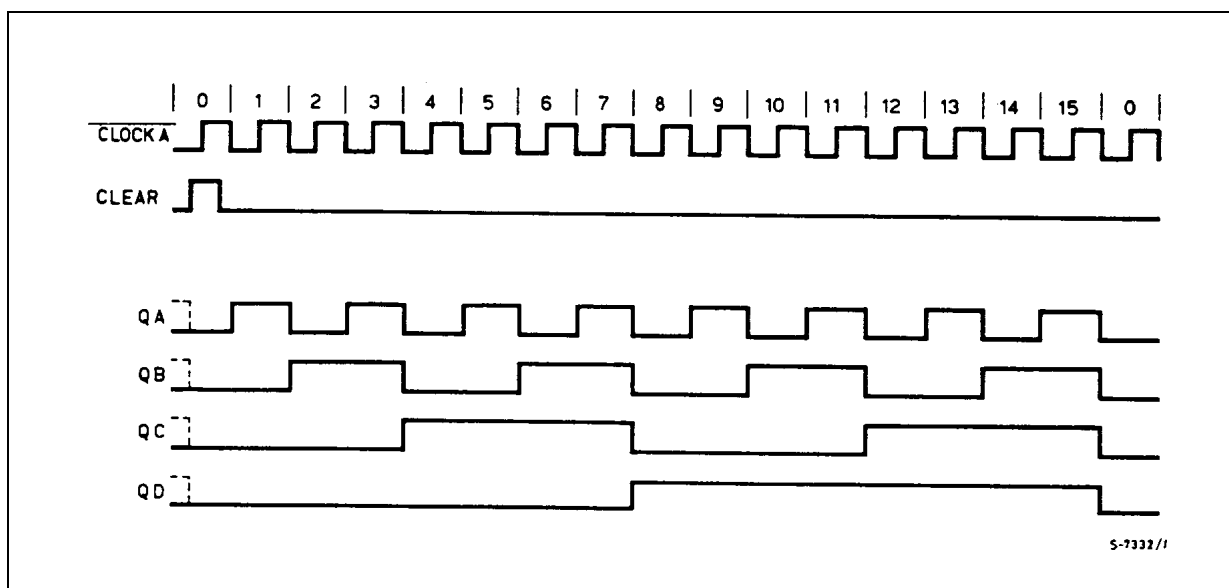
| COUNT | OUTPUTS | | | |
|-------|---------|----|----|----|
| | QD | QC | QB | QA |
| 0 | L | L | L | L |
| 1 | L | L | L | H |
| 2 | L | L | H | L |
| 3 | L | L | H | H |
| 4 | L | H | L | L |
| 5 | L | H | L | H |
| 6 | L | H | H | L |
| 7 | L | H | H | H |
| 8 | H | L | L | L |
| 9 | H | L | L | H |
| 10 | H | L | H | L |
| 11 | H | L | H | H |
| 12 | H | H | L | L |
| 13 | H | H | L | H |
| 14 | H | H | H | L |
| 15 | H | H | H | H |

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 ($C_L = 50 \text{ pF}$, Input $t_r = t_f = 6 \text{ ns}$)

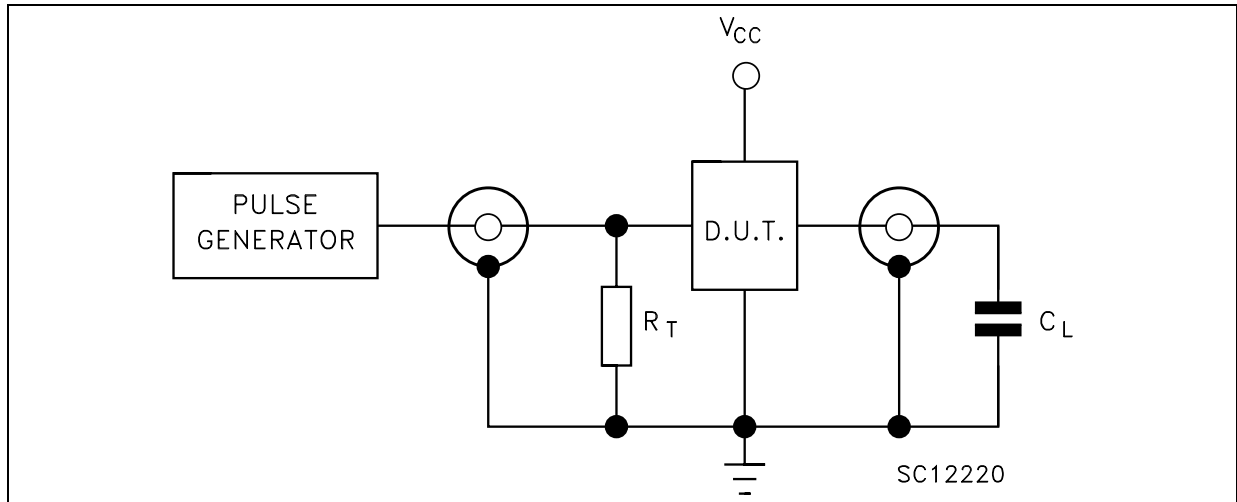
| Symbol | Parameter | Test Condition | | Value | | | | | | Unit | |
|--|--|------------------------|--|-----------------------|------|------|-------------|------|--------------|------|------|
| | | V _{CC} (V) | | T _A = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | 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 (CLOCK - QA) | 2.0 | | | 50 | 120 | | 150 | | 180 | ns |
| | | 4.5 | | | 15 | 24 | | 30 | | 36 | |
| | | 6.0 | | | 13 | 20 | | 26 | | 31 | |
| t _{PLH} t _{PHL} | Propagation Delay Time (CLOCK - QB) | 2.0 | | | 70 | 160 | | 200 | | 240 | ns |
| | | 4.5 | | | 20 | 32 | | 40 | | 48 | |
| | | 6.0 | | | 17 | 27 | | 34 | | 41 | |
| t _{PLH} t _{PHL} | Propagation Delay Time (CLOCK - QC) | 2.0 | | | 90 | 195 | | 245 | | 295 | ns |
| | | 4.5 | | | 25 | 39 | | 49 | | 59 | |
| | | 6.0 | | | 21 | 33 | | 42 | | 50 | |
| t _{PLH} t _{PHL} | Propagation Delay Time (CLOCK - QD) | 2.0 | | | 120 | 230 | | 290 | | 345 | ns |
| | | 4.5 | | | 30 | 46 | | 58 | | 69 | |
| | | 6.0 | | | 26 | 39 | | 49 | | 59 | |
| t _{PHL} | Propagation Delay Time (CLEAR - Qn) | 2.0 | | | 55 | 150 | | 190 | | 225 | ns |
| | | 4.5 | | | 18 | 30 | | 38 | | 45 | |
| | | 6.0 | | | 15 | 26 | | 32 | | 38 | |
| f _{MAX} | Maximum Clock Frequency | 2.0 | | 8.4 | 17 | | 6.8 | | 5.6 | | MHz |
| | | 4.5 | | 42 | 67 | | 34 | | 28 | | |
| | | 6.0 | | 50 | 79 | | 40 | | 33 | | |
| t _{W(H)} t _{W(L)} | Minimum Pulse Width (CLOCK) | 2.0 | | | 28 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 7 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 6 | 13 | | 16 | | 19 | |
| t _{W(H)} | Minimum Pulse Width (CLEAR) | 2.0 | | | 28 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 7 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 6 | 13 | | 16 | | 19 | |
| t _{REM} | Minimum Removal Time | 2.0 | | | | 25 | | 30 | | 35 | ns |
| | | 4.5 | | | | 5 | | 6 | | 7 | |
| | | 6.0 | | | | 5 | | 5 | | 6 | |

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 | 10 | | 10 | | 10 | pF |
| C _{PD} | Power Dissipation Capacitance (note 1) | | | | 35 | | | | | | 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. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/4$ (per FLIP FLOP)

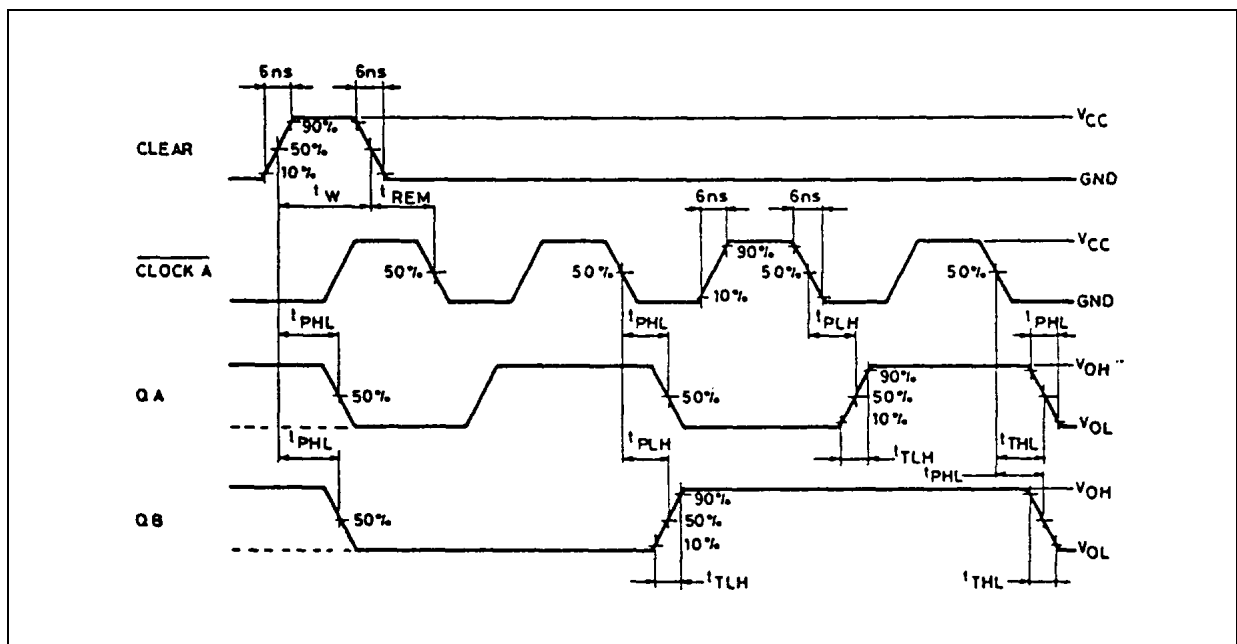
TEST CIRCUIT



$C_L = 50\text{pF}$ or equivalent (includes jig and probe capacitance)

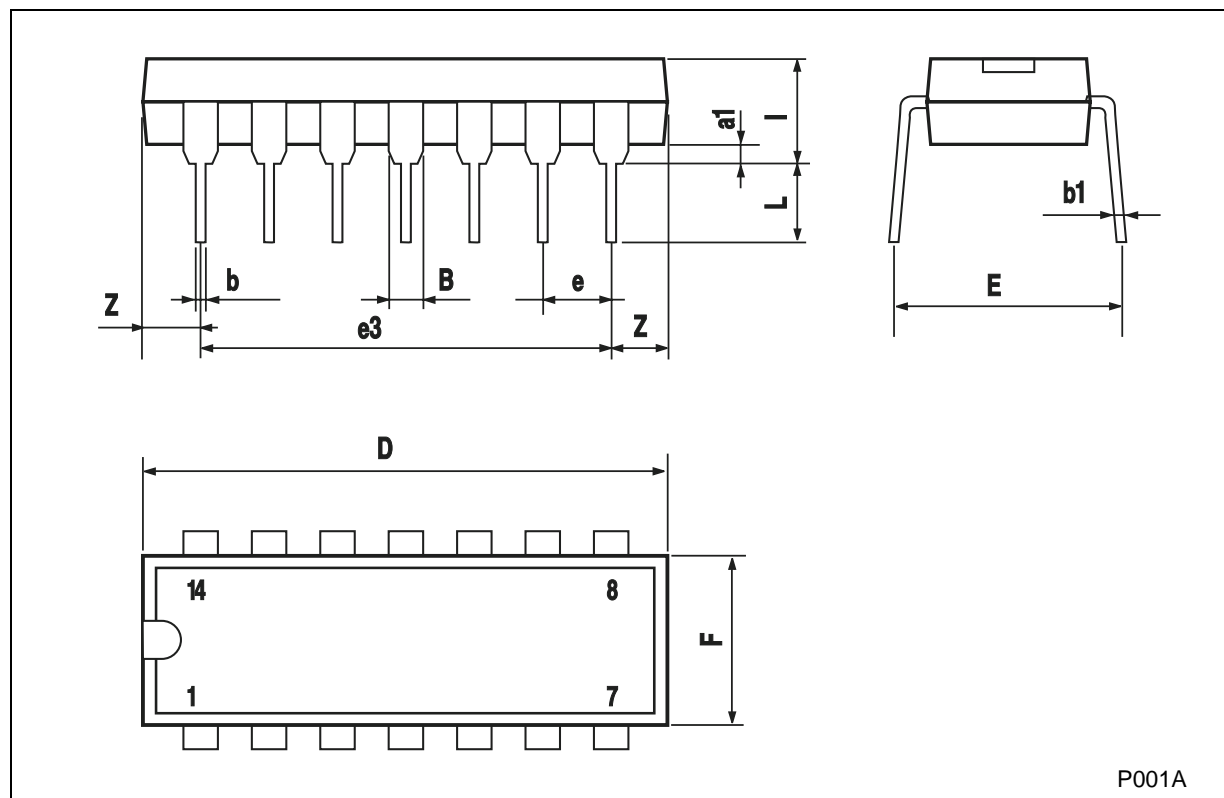
$R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

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



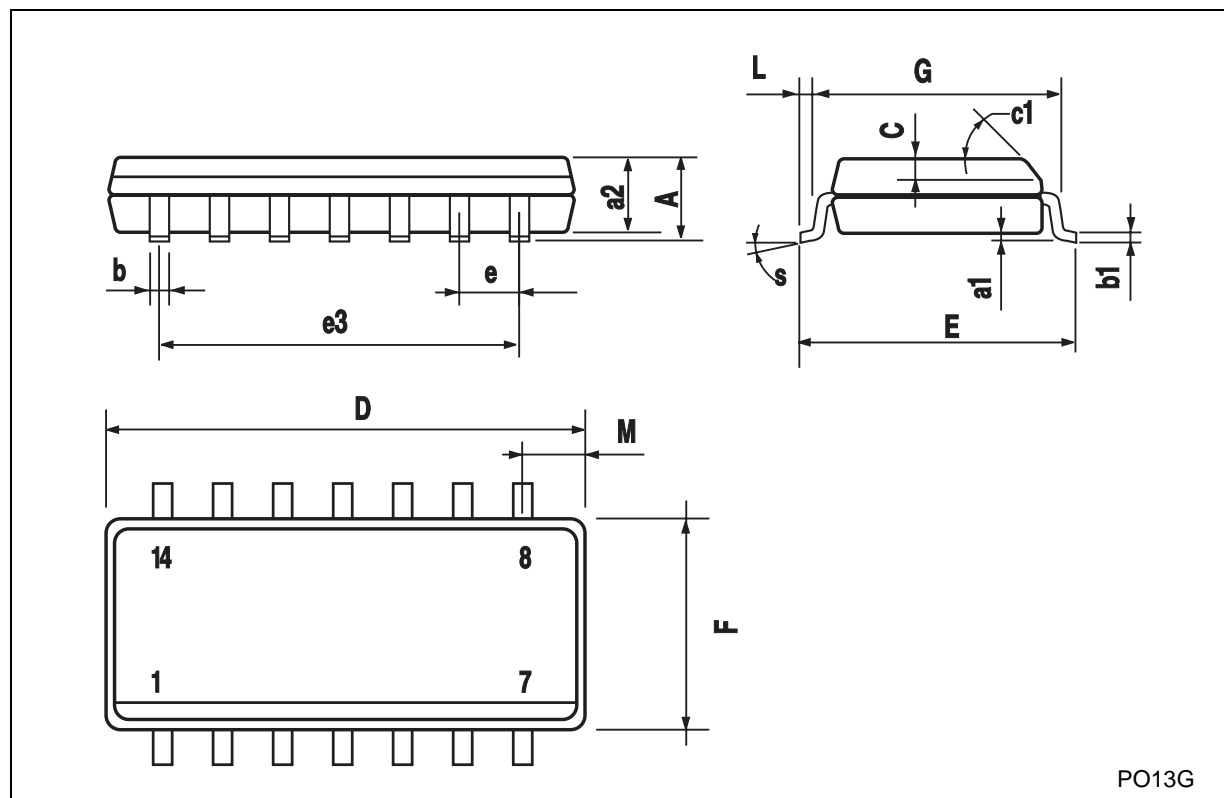
Plastic DIP-14 MECHANICAL DATA

| 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 |



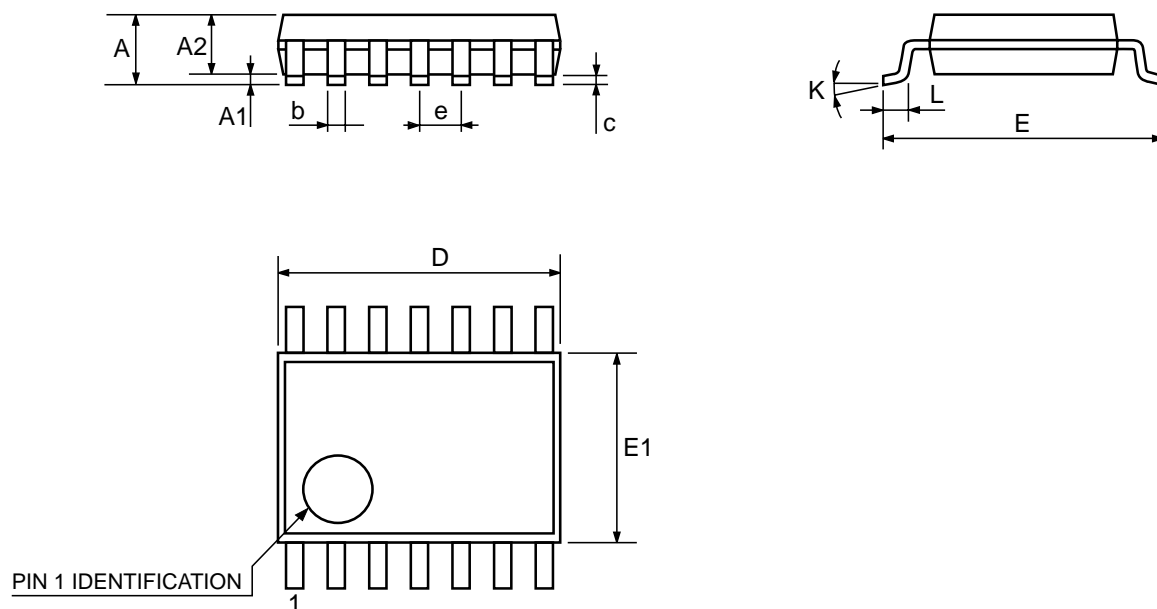
SO-14 MECHANICAL DATA

| 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.) | | | | | |



TSSOP14 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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