

**TOSHIBA****TC74HC161, 163AP/AF/AFN**

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

**TC74HC161AP, TC74HC161AF, TC74HC161AFN**  
**TC74HC163AP, TC74HC163AF, TC74HC163AFN****SYNCHRONOUS PRESETTABLE 4 - BIT COUNTER****TC74HC161AP/AF/AFN BINARY, ASYNCHRONOUS CLEAR**  
**TC74HC163AP/AF/AFN BINARY, SYNCHRONOUS CLEAR**

(Note) The JEDEC SOP (FN) is not available in Japan.

The TC74HC161A and 163A are high speed CMOS BINARY PRESETTABLE COUNTERS fabricated with silicon gate C<sup>2</sup>MOS technology.

They achieve the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation. The CK input is active on the rising edge. Both  $\overline{\text{LOAD}}$  and  $\overline{\text{CLR}}$  inputs are active on low logic level.

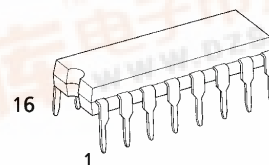
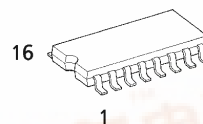
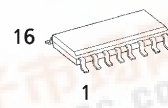
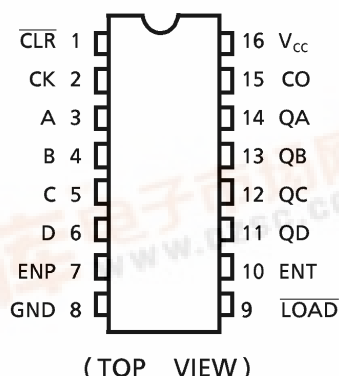
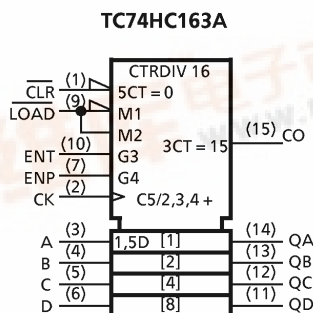
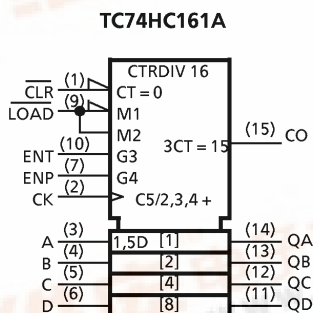
Presetting of all four IC's is synchronous to the rising edge of CK.

The clear function of the TC74HC163A is synchronous to CK, while the TC74HC161A is cleared asynchronously.

Two enable inputs (ENP and ENT) and CO are provided to enable easy cascading of counters, which facilitates easy implementation of n-bit counters without using external gates. All inputs are equipped with protection circuits against static discharge or transient excess voltage.

**FEATURES:**

- High Speed.....  $f_{\text{MAX}} = 63\text{MHz}(\text{typ.})$  at  $V_{\text{CC}} = 5\text{V}$
- Low Power Dissipation.....  $I_{\text{CC}} = 4\mu\text{A}(\text{Max.})$  at  $T_a = 25^\circ\text{C}$
- High Noise Immunity.....  $V_{\text{NIH}} = V_{\text{NIL}} = 28\% V_{\text{CC}}(\text{Min.})$
- Output Drive Capability..... 10 LSTTL Loads
- Symmetrical Output Impedance...  $|I_{\text{OH}}| = |I_{\text{OL}}| = 4\text{mA}(\text{Min.})$
- Balanced Propagation Delays.....  $t_{\text{PLH}} \approx t_{\text{PHL}}$
- Wide Operating Voltage Range...  $V_{\text{CC}}(\text{opr.}) = 2\text{V} \sim 6\text{V}$
- Pin and Function Compatible with 74LS161, 163

P (DIP16-P-300-2.54A)  
Weight : 1.00g (Typ.)F (SOP16-P-300-1.27)  
Weight : 0.18g (Typ.)FN (SOL16-P-150-1.27)  
Weight : 0.13g (Typ.)**PIN ASSIGNMENT****IEC LOGIC SYMBOL**

980508EBA2

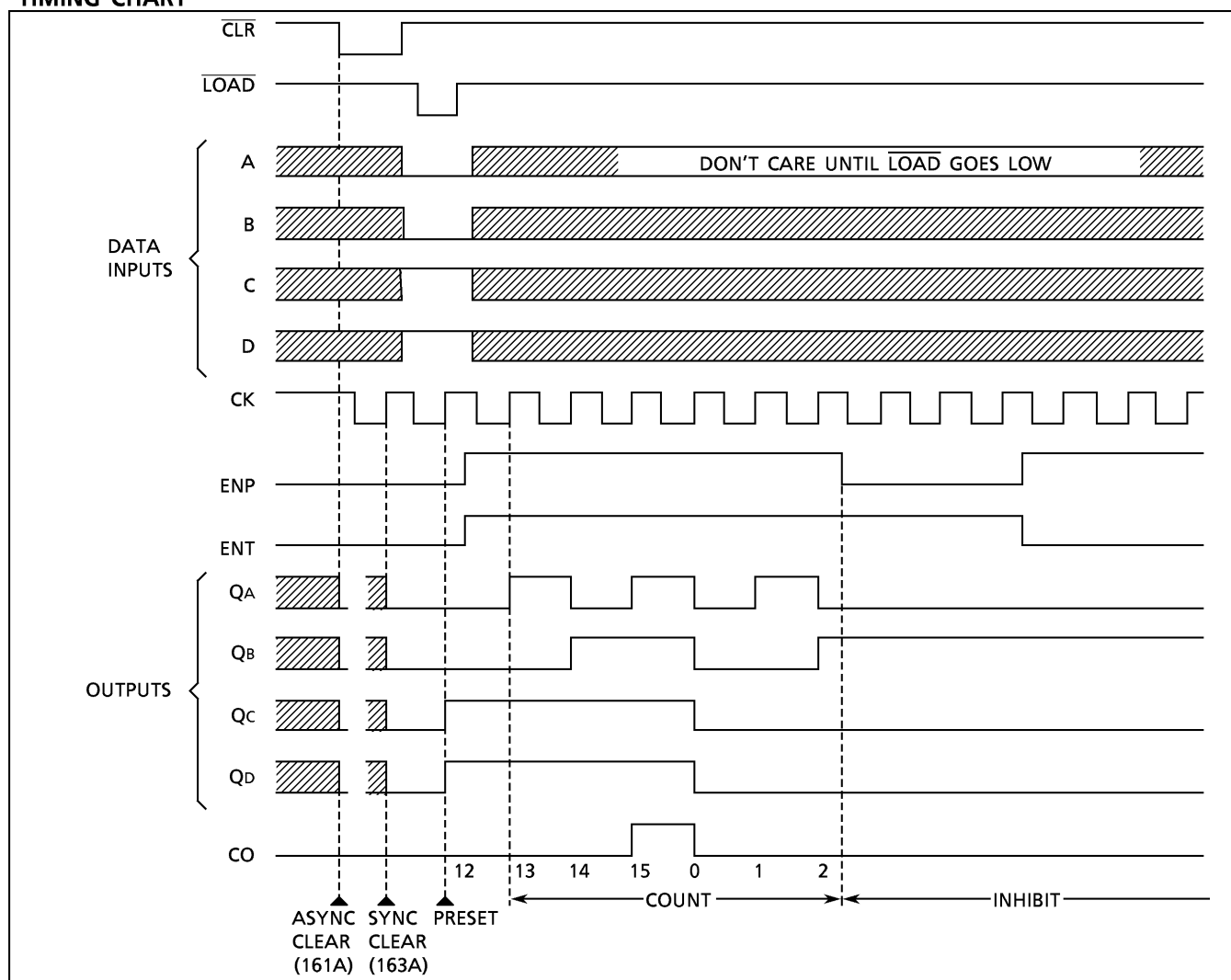
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TRUTH TABLE

| TC74HC161A |    |     |     |              | TC74HC163A |    |     |     |              | OUTPUTS   |    |    |    | FUNCTION     |
|------------|----|-----|-----|--------------|------------|----|-----|-----|--------------|-----------|----|----|----|--------------|
| INPUTS     |    |     |     |              | INPUTS     |    |     |     |              | QA        | QB | QC | QD |              |
| CLR        | LD | ENP | ENT | CK           | CLR        | LD | ENP | ENT | CK           |           |    |    |    |              |
| L          | X  | X   | X   | X            | L          | X  | X   | X   | $\uparrow$   | L         | L  | L  | L  | RESET TO "0" |
| H          | L  | X   | X   | $\uparrow$   | H          | L  | X   | X   | $\uparrow$   | A         | B  | C  | D  | PRESET DATA  |
| H          | H  | X   | L   | $\uparrow$   | H          | H  | X   | L   | $\uparrow$   | NO CHANGE |    |    |    | NO COUNT     |
| H          | H  | L   | X   | $\uparrow$   | H          | H  | L   | X   | $\uparrow$   | NO CHANGE |    |    |    | NO COUNT     |
| H          | H  | H   | H   | $\uparrow$   | H          | H  | H   | H   | $\uparrow$   | COUNT UP  |    |    |    | COUNT        |
| H          | X  | X   | X   | $\downarrow$ | X          | X  | X   | X   | $\downarrow$ | NO CHANGE |    |    |    | NO COUNT     |

Note X : Don't Care  
 A, B, C, D : Logic Level of Data Inputs  
 Carry :  $CARRY = ENT \cdot QA \cdot QB \cdot QC \cdot QD$

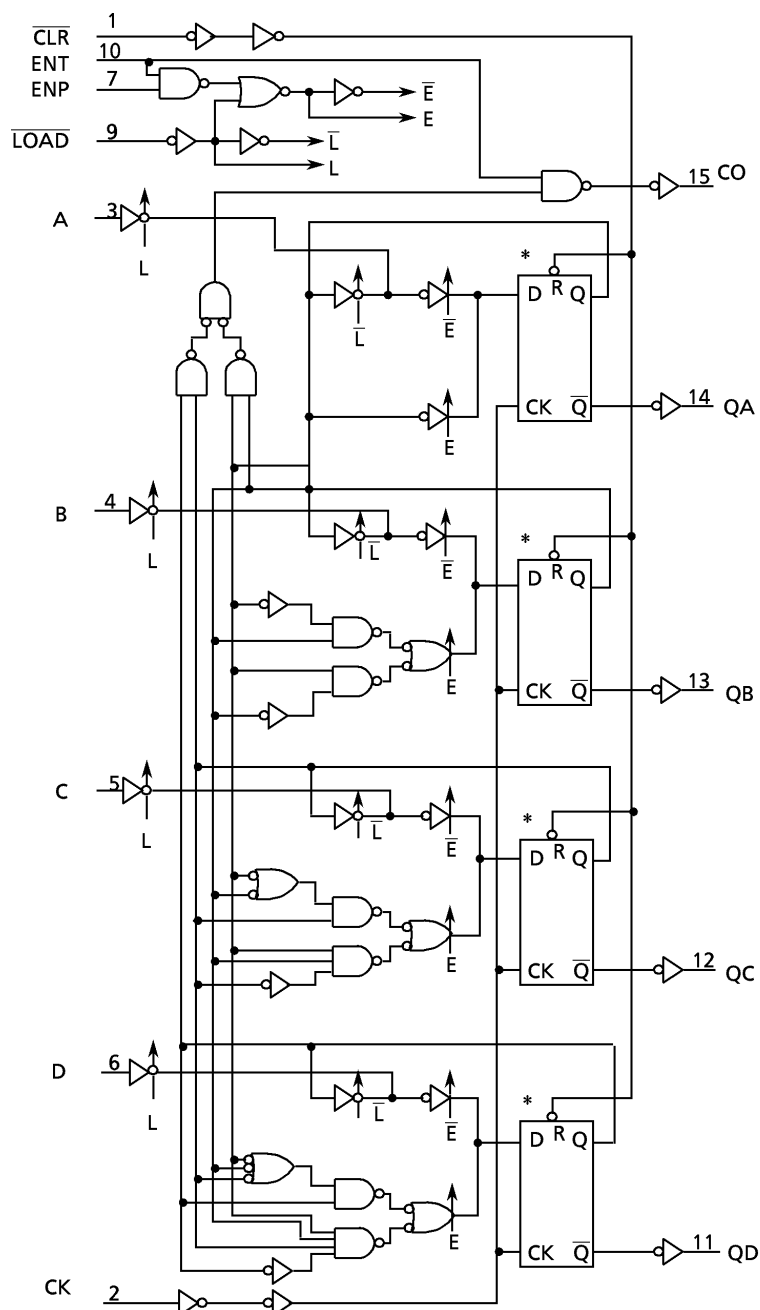
TIMING CHART



980508EBA2'

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**SYSTEM DIAGRAM**



\* TRUTH TABLE OF INTERNAL F/F

| TC74HC161A |            |   |           |           | TC74HC163A |            |   |           |           |
|------------|------------|---|-----------|-----------|------------|------------|---|-----------|-----------|
| D          | CK         | R | Q         | $\bar{Q}$ | D          | CK         | R | Q         | $\bar{Q}$ |
| X          | X          | L | L         | H         | X          | $\uparrow$ | L | L         | H         |
| L          | $\uparrow$ | H | L         | H         | L          | $\uparrow$ | H | L         | H         |
| H          | $\uparrow$ | H | H         | L         | H          | $\uparrow$ | H | H         | L         |
| X          | $\uparrow$ | X | NO CHANGE |           | X          | $\uparrow$ | H | NO CHANGE |           |

X : Don't Care

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER                    | SYMBOL    | VALUE                    | UNIT |
|------------------------------|-----------|--------------------------|------|
| Supply Voltage Range         | $V_{CC}$  | $-0.5 \sim 7$            | V    |
| DC Input Voltage             | $V_{IN}$  | $-0.5 \sim V_{CC} + 0.5$ | V    |
| DC Output Voltage            | $V_{OUT}$ | $-0.5 \sim V_{CC} + 0.5$ | V    |
| Input Diode Current          | $I_{IK}$  | $\pm 20$                 | mA   |
| Output Diode Current         | $I_{OK}$  | $\pm 20$                 | mA   |
| DC Output Current            | $I_{OUT}$ | $\pm 25$                 | mA   |
| DC $V_{CC}$ / Ground Current | $I_{CC}$  | $\pm 50$                 | mA   |
| Power Dissipation            | $P_D$     | 500 (DIP)* / 180 (SOP)   | mW   |
| Storage Temperature          | $T_{stg}$ | $-65 \sim 150$           | °C   |

\*500mW in the range of  $T_a = -40^\circ\text{C} \sim 65^\circ\text{C}$ . From  $T_a = 65^\circ\text{C}$  to  $85^\circ\text{C}$  a derating factor of  $-10\text{mW}/^\circ\text{C}$  shall be applied until 300mW.

## RECOMMENDED OPERATING CONDITIONS

| PARAMETER                | SYMBOL     | VALUE                                                                                                                          | UNIT |
|--------------------------|------------|--------------------------------------------------------------------------------------------------------------------------------|------|
| Supply Voltage           | $V_{CC}$   | $2 \sim 6$                                                                                                                     | V    |
| Input Voltage            | $V_{IN}$   | $0 \sim V_{CC}$                                                                                                                | V    |
| Output Voltage           | $V_{OUT}$  | $0 \sim V_{CC}$                                                                                                                | V    |
| Operating Temperature    | $T_{opr}$  | $-40 \sim 85$                                                                                                                  | °C   |
| Input Rise and Fall Time | $t_r, t_f$ | $0 \sim 1000$ ( $V_{CC} = 2.0\text{V}$ )<br>$0 \sim 500$ ( $V_{CC} = 4.5\text{V}$ )<br>$0 \sim 400$ ( $V_{CC} = 6.0\text{V}$ ) | ns   |

## DC ELECTRICAL CHARACTERISTICS

| PARAMETER                   | SYMBOL   | TEST CONDITION                       | $V_{CC}$<br>(V)            | $T_a = 25^\circ\text{C}$ |                   |                      | $T_a = -40 \sim 85^\circ\text{C}$ |                      | UNIT          |
|-----------------------------|----------|--------------------------------------|----------------------------|--------------------------|-------------------|----------------------|-----------------------------------|----------------------|---------------|
|                             |          |                                      |                            | MIN.                     | TYP.              | MAX.                 | MIN.                              | MAX.                 |               |
| High - Level Input Voltage  | $V_{IH}$ |                                      | 2.0<br>4.5<br>6.0          | 1.50<br>3.15<br>4.20     | —<br>—<br>—       | —<br>—<br>—          | 1.50<br>3.15<br>4.20              | —<br>—<br>—          | V             |
| Low - Level Input Voltage   | $V_{IL}$ |                                      | 2.0<br>4.5<br>6.0          | —<br>—<br>—              | —<br>—<br>—       | 0.50<br>1.35<br>1.80 | —<br>—<br>—                       | 0.50<br>1.35<br>1.80 | V             |
| High - Level Output Voltage | $V_{OH}$ | $V_{IN} = V_{IH} \text{ or } V_{IL}$ | $I_{OH} = -20\mu\text{A}$  | 2.0<br>4.5<br>6.0        | 1.9<br>4.4<br>5.9 | 2.0<br>4.5<br>6.0    | —<br>—<br>—                       | 1.9<br>4.4<br>5.9    | V             |
|                             |          |                                      | $I_{OH} = -4 \text{ mA}$   | 4.5<br>6.0               | 4.18<br>5.68      | 4.31<br>5.80         | —<br>—                            | 4.13<br>5.63         |               |
|                             |          |                                      | $I_{OH} = -5.2 \text{ mA}$ | 6.0                      | 5.68              | —                    | —                                 | —                    |               |
| Low - Level Output Voltage  | $V_{OL}$ | $V_{IN} = V_{IH} \text{ or } V_{IL}$ | $I_{OL} = 20\mu\text{A}$   | 2.0<br>4.5<br>6.0        | —<br>—<br>—       | 0.0<br>0.0<br>0.1    | 0.1<br>0.1<br>0.1                 | —<br>—<br>—          | V             |
|                             |          |                                      | $I_{OL} = 4 \text{ mA}$    | 4.5<br>6.0               | —<br>—            | 0.17<br>0.18         | 0.26<br>0.26                      | —<br>—               |               |
|                             |          |                                      | $I_{OL} = 5.2 \text{ mA}$  | 6.0                      | —                 | —                    | —                                 | 0.33<br>0.33         |               |
| Input Leakage Current       | $I_{IN}$ | $V_{IN} = V_{CC} \text{ or GND}$     | 6.0                        | —                        | —                 | $\pm 0.1$            | —                                 | $\pm 1.0$            | $\mu\text{A}$ |
| Quiescent Supply Current    | $I_{CC}$ | $V_{IN} = V_{CC} \text{ or GND}$     | 6.0                        | —                        | —                 | 4.0                  | —                                 | 40.0                 |               |

TIMING REQUIREMENTS (Input  $t_r = t_f = 6\text{ns}$ )

| PARAMETER                                                  | SYMBOL                   | TEST CONDITION | $V_{CC}$ (V) | $T_a = 25^\circ\text{C}$ |       | $T_a = -40 \sim 85^\circ\text{C}$ | UNIT |
|------------------------------------------------------------|--------------------------|----------------|--------------|--------------------------|-------|-----------------------------------|------|
|                                                            |                          |                |              | TYP.                     | LIMIT | LIMIT                             |      |
| Minimum Pulse Width (CK)                                   | $t_{W(H)}$<br>$t_{W(L)}$ | Fig. 1         | 2.0          | —                        | 75    | 95                                | ns   |
|                                                            |                          |                | 4.5          | —                        | 15    | 19                                |      |
|                                                            |                          |                | 6.0          | —                        | 13    | 16                                |      |
| Minimum Pulse Width ( $\overline{\text{CLR}}$ ) *          | $t_{W(L)}$               | Fig. 4         | 2.0          | —                        | 75    | 95                                |      |
|                                                            |                          |                | 4.5          | —                        | 15    | 19                                |      |
|                                                            |                          |                | 6.0          | —                        | 13    | 16                                |      |
| Minimum Set-up Time ( $\overline{\text{LOAD}}$ , ENP, ENT) | $t_s$                    | Fig. 2, 3      | 2.0          | —                        | 100   | 125                               |      |
|                                                            |                          |                | 4.5          | —                        | 20    | 25                                |      |
|                                                            |                          |                | 6.0          | —                        | 17    | 21                                |      |
| Minimum Set-up Time (A, B, C, D)                           | $t_s$                    | Fig. 2         | 2.0          | —                        | 75    | 95                                |      |
|                                                            |                          |                | 4.5          | —                        | 15    | 19                                |      |
|                                                            |                          |                | 6.0          | —                        | 13    | 16                                |      |
| Minimum Set-up Time ( $\overline{\text{CLR}}$ ) **         | $t_s$                    | Fig. 5         | 2.0          | —                        | 75    | 95                                |      |
|                                                            |                          |                | 4.5          | —                        | 15    | 19                                |      |
|                                                            |                          |                | 6.0          | —                        | 13    | 16                                |      |
| Minimum Hold Time                                          | $t_h$                    | Fig. 2, 3, 5   | 2.0          | —                        | 0     | 0                                 |      |
|                                                            |                          |                | 4.5          | —                        | 0     | 0                                 |      |
|                                                            |                          |                | 6.0          | —                        | 0     | 0                                 |      |
| Minimum Removal Time ( $\overline{\text{CLR}}$ ) *         | $t_{\text{rem}}$         | Fig. 4         | 2.0          | —                        | 50    | 65                                |      |
|                                                            |                          |                | 4.5          | —                        | 10    | 13                                |      |
|                                                            |                          |                | 6.0          | —                        | 9     | 11                                |      |
| Clock Frequency                                            | $f$                      |                | 2.0          | —                        | 6     | 5                                 | MHz  |
|                                                            |                          |                | 4.5          | —                        | 31    | 25                                |      |
|                                                            |                          |                | 6.0          | —                        | 36    | 29                                |      |

AC ELECTRICAL CHARACTERISTICS ( $C_L = 15\text{pF}$ ,  $V_{CC} = 5\text{V}$ ,  $T_a = 25^\circ\text{C}$ , Input  $t_r = t_f = 6\text{ns}$ )

| PARAMETER                                               | SYMBOL                 | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|---------------------------------------------------------|------------------------|----------------|------|------|------|------|
| Output Transition Time                                  | $t_{TLH}$<br>$t_{THL}$ | Fig. 1         | —    | 4    | 8    | ns   |
| Propagation Delay Time (CK—Q)                           | $t_{PLH}$<br>$t_{PHL}$ | Fig. 1         | —    | 13   | 21   |      |
| Propagation Delay Time (CK—CO)<br>[Count Mode]          | $t_{PLH}$<br>$t_{PHL}$ | Fig. 1         | —    | 16   | 26   |      |
| Propagation Delay Time (CK—CO)<br>[Preset Mode]         | $t_{PLH}$              | Fig. 2         | —    | 18   | 30   |      |
|                                                         | $t_{PHL}$              |                | —    | 20   | 35   |      |
| Propagation Delay Time (ENT—CO)                         | $t_{PLH}$<br>$t_{PHL}$ | Fig. 6         | —    | 10   | 17   |      |
| Propagation Delay Time ( $\overline{\text{CLR}}$ —Q) *  | $t_{PHL}$              | Fig. 4         | —    | 17   | 26   |      |
| Propagation Delay Time ( $\overline{\text{CLR}}$ —CO) * | $t_{PHL}$              | Fig. 4         | —    | 20   | 35   | MHz  |
| Maximum Clock Frequency                                 | $f_{\text{MAX}}$       |                | 36   | 63   | —    |      |

\*: for TC74HC161A only

\*\*: for TC74HC163A only

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

| PARAMETER                                                 | SYMBOL                               | TEST CONDITION | Ta = 25°C           |      |      |      | Ta = -40~85°C |      | UNIT |
|-----------------------------------------------------------|--------------------------------------|----------------|---------------------|------|------|------|---------------|------|------|
|                                                           |                                      |                | V <sub>CC</sub> (V) | MIN. | TYP. | MAX. | MIN.          | MAX. |      |
| Output Transition Time                                    | t <sub>TLH</sub><br>t <sub>THL</sub> |                | 2.0                 | —    | 25   | 75   | —             | 95   | ns   |
|                                                           |                                      |                | 4.5                 | —    | 7    | 15   | —             | 19   |      |
|                                                           |                                      |                | 6.0                 | —    | 6    | 13   | —             | 16   |      |
| Propagation Delay Time<br>(CK—Q)                          | Fig. 1                               | 2.0            | —                   | 48   | 125  | —    | 155           |      |      |
|                                                           |                                      | 4.5            | —                   | 16   | 25   | —    | 31            |      |      |
|                                                           |                                      | 6.0            | —                   | 14   | 21   | —    | 26            |      |      |
| Propagation Delay Time<br>(CK—CO)<br>[ Count Mode ]       | Fig. 1                               | 2.0            | —                   | 57   | 150  | —    | 190           |      |      |
|                                                           |                                      | 4.5            | —                   | 19   | 30   | —    | 38            |      |      |
|                                                           |                                      | 6.0            | —                   | 16   | 26   | —    | 33            |      |      |
| Propagation Delay Time<br>(CK—CO)<br>[ Preset Mode ]      | t <sub>pLH</sub>                     | Fig. 2         | 2.0                 | —    | 66   | 175  | —             | 220  |      |
|                                                           |                                      |                | 4.5                 | —    | 22   | 35   | —             | 44   |      |
|                                                           |                                      |                | 6.0                 | —    | 19   | 30   | —             | 37   |      |
|                                                           | t <sub>pHL</sub>                     |                | 2.0                 | —    | 72   | 200  | —             | 250  |      |
|                                                           |                                      |                | 4.5                 | —    | 24   | 40   | —             | 50   |      |
|                                                           |                                      |                | 6.0                 | —    | 20   | 34   | —             | 43   |      |
| Propagation Delay Time<br>(ENT—CO)                        | Fig. 6                               | 2.0            | —                   | 39   | 100  | —    | 125           |      |      |
|                                                           |                                      | 4.5            | —                   | 13   | 20   | —    | 25            |      |      |
|                                                           |                                      | 6.0            | —                   | 11   | 17   | —    | 21            |      |      |
| Propagation Delay Time<br>(CLR—Q)*                        | Fig. 4                               | 2.0            | —                   | 60   | 150  | —    | 190           |      |      |
|                                                           |                                      | 4.5            | —                   | 20   | 30   | —    | 38            |      |      |
|                                                           |                                      | 6.0            | —                   | 17   | 26   | —    | 33            |      |      |
| Propagation Delay Time<br>( $\overline{\text{CLR}}$ —CO)* | Fig. 4                               | 2.0            | —                   | 72   | 200  | —    | 250           |      |      |
|                                                           |                                      | 4.5            | —                   | 24   | 40   | —    | 50            |      |      |
|                                                           |                                      | 6.0            | —                   | 20   | 34   | —    | 43            |      |      |
| Maximum Clock Frequency                                   | f <sub>MAX</sub>                     |                | 2.0                 | 6    | 18   | —    | 5             | —    | MHz  |
|                                                           |                                      |                | 4.5                 | 31   | 53   | —    | 25            | —    |      |
|                                                           |                                      |                | 6.0                 | 36   | 62   | —    | 29            | —    |      |
| Input Capacitance                                         | C <sub>IN</sub>                      |                |                     | —    | 5    | 10   | —             | 10   | pF   |
| Power Dissipation Capacitance                             | C <sub>PD</sub> (1)                  |                |                     | —    | 34   | —    | —             | —    |      |

Note (1)  $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

$$I_{CC}(\text{opr}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

When the outputs drive a capacitive load, total current consumption is the sum of  $C_{PD}$ , and  $\Delta I_{CC}$  which is obtained from the following formula :

In case of TC74HC161A / 163A :

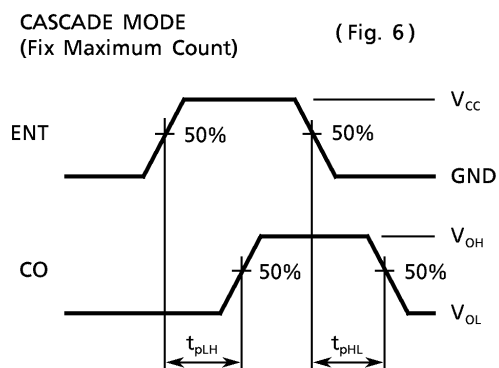
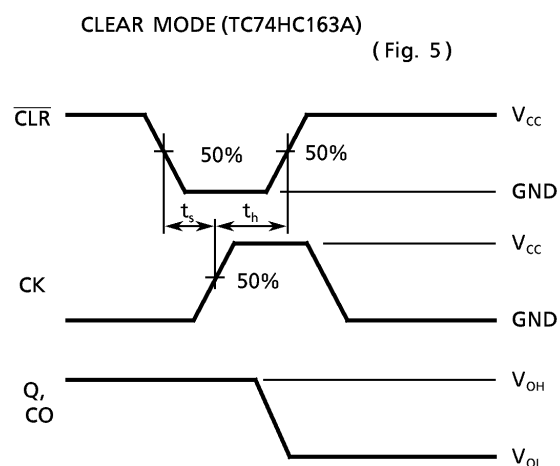
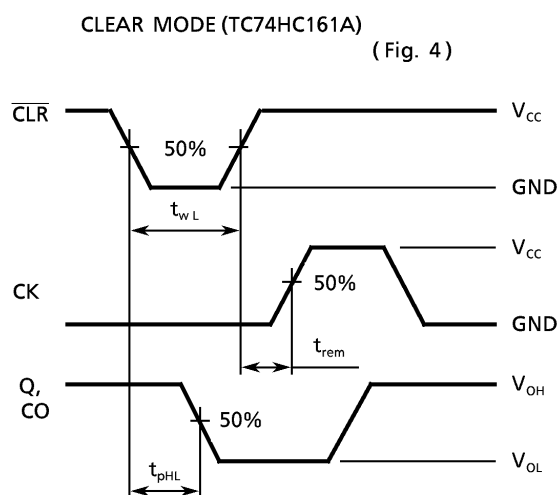
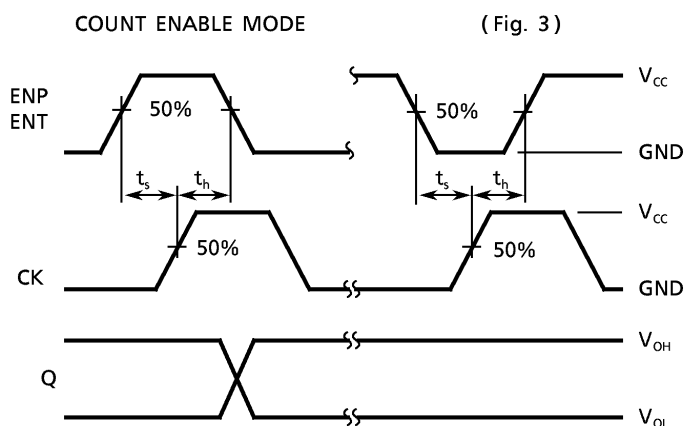
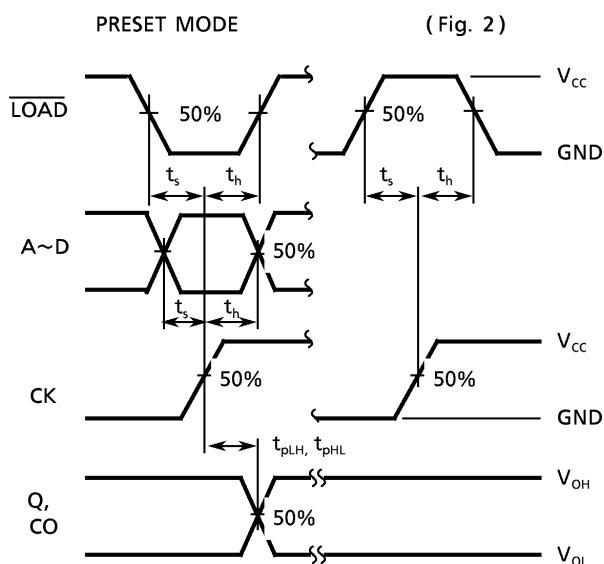
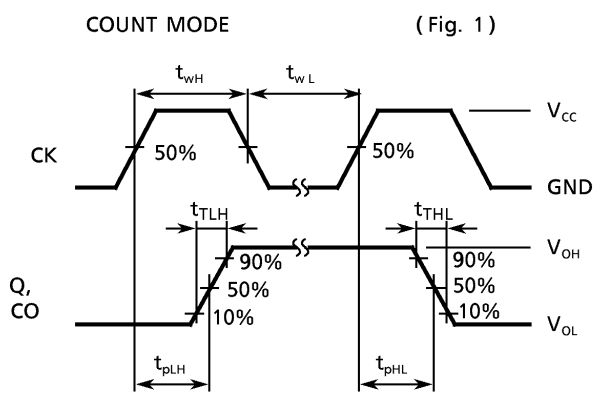
$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \left( \frac{C_{QA}}{2} + \frac{C_{QB}}{4} + \frac{C_{QC}}{8} + \frac{C_{QD}}{16} + \frac{C_{CO}}{16} \right)$$

$C_{QA} \sim C_{QD}$  and  $C_{CO}$  are the capacitances at QA~QD and CO, respectively.

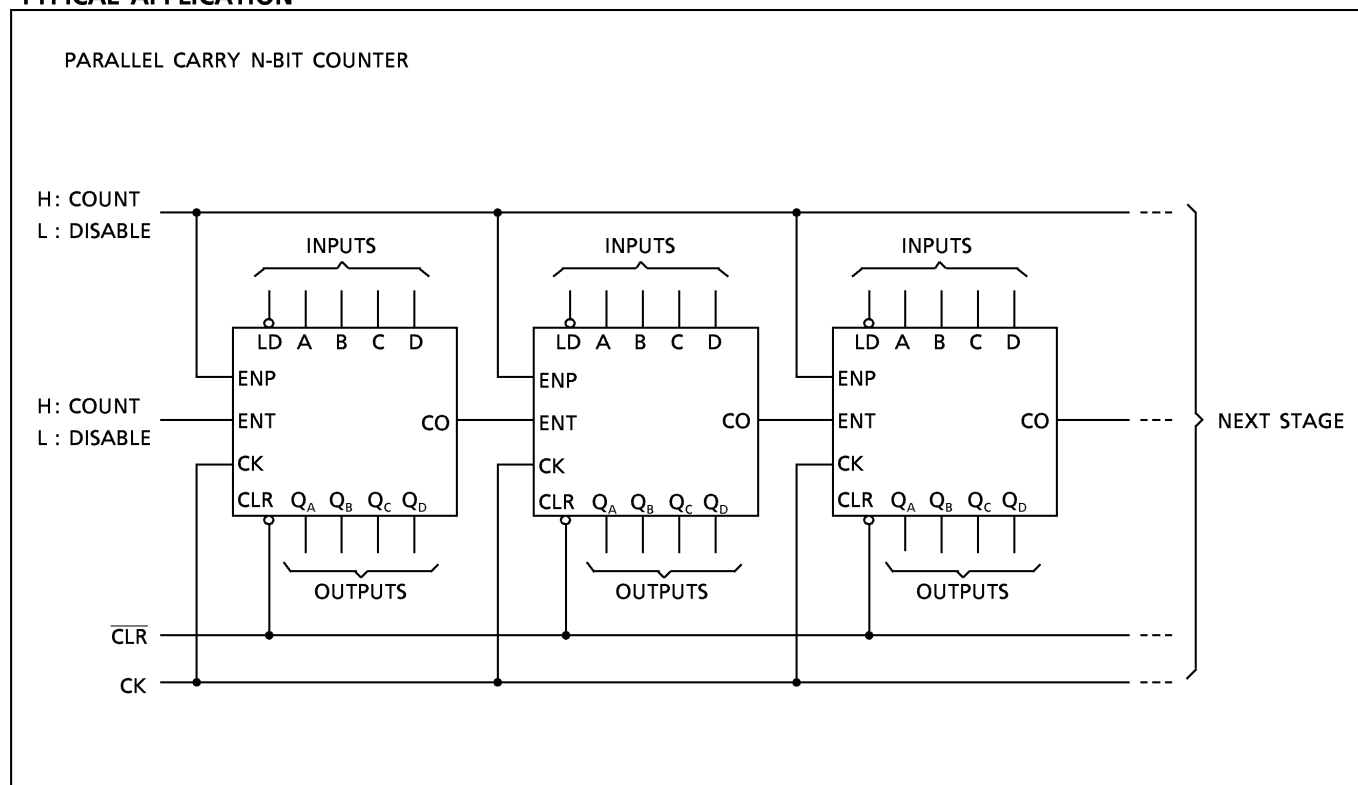
$f_{CK}$  is the input frequency of the CK.

\* for TC74HC161A only

**SWITCHING CHARACTERISTICS TEST WAVEFORM**



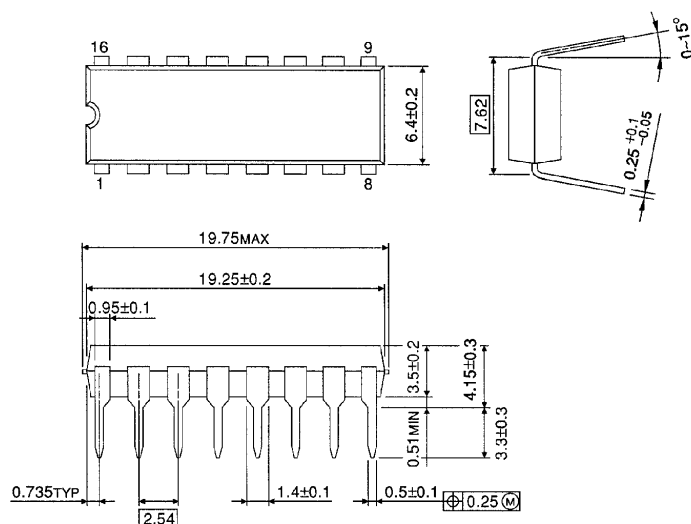
**TYPICAL APPLICATION**





DIP 16PIN OUTLINE DRAWING (DIP16-P-300-2.54A)

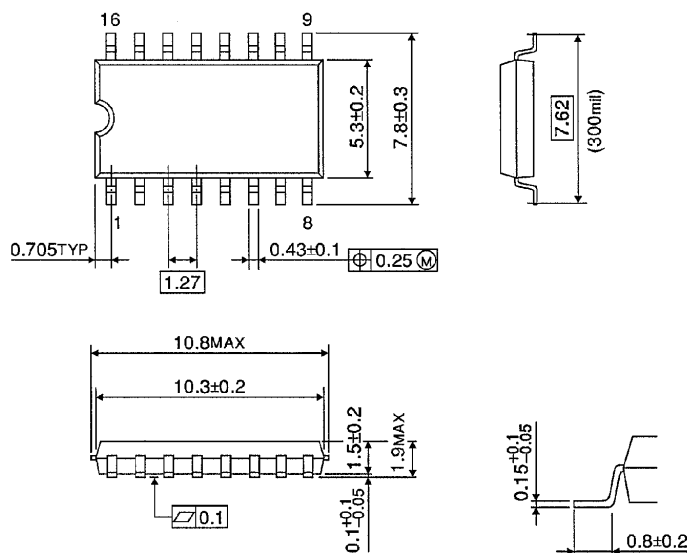
Unit in mm



Weight : 1.00g (Typ.)

SOP 16PIN ( 200mil BODY ) OUTLINE DRAWING (SOP16-P-300-1.27)

Unit in mm

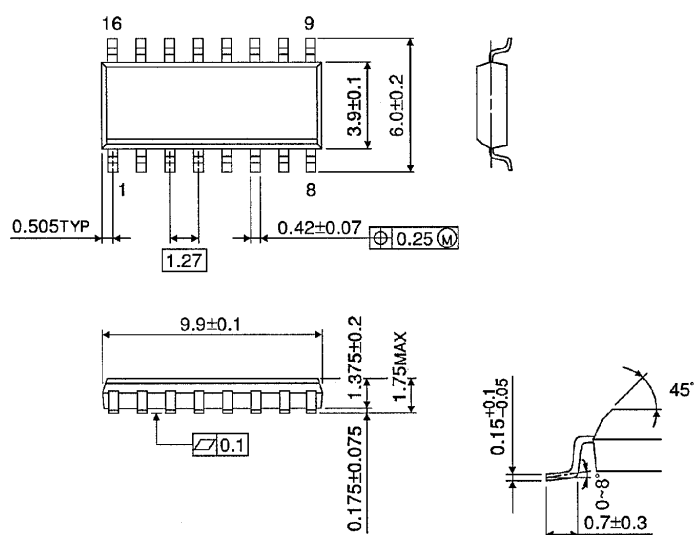


Weight : 0.18g (Typ.)

## SOP 16PIN ( 150mil BODY ) OUTLINE DRAWING (SOL16-P-150 -1.27)

Unit in mm

(Note) This package is not available in Japan.



Weight : 0.13g (Typ.)