

# TC74HC191AP, TC74HC191AF

## 4 - BIT BINARY UP/DOWN COUNTER

The TC74HC191A are high speed CMOS 4-BIT UP/DOWN COUNTERs fabricated with silicon gate C<sup>2</sup>MOS technology. It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation. The TC74HC191A is 4-bit binary up/down counter.

They have a asynchronous load input (LOAD) which is active low.

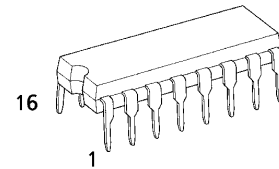
The direction of counting is determined by the level of DOWN/UP. When D/U is low, the counter counts up; when D/U is high, it counts down. Counting occurs on the positive going transition of the clock input.

Enable input (ENABLE) and two carry inputs (RIPPLE CLOCK OUT, MAX/MIN) are provided to permit easy cascading of the counters, which facilitates easy implementation of N-bit counters without using external gates.

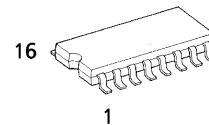
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

### FEATURES:

- High Speed..... $f_{MAX} = 48\text{MHz}$  (typ.)  
at  $V_{CC} = 5\text{V}$
- Low Power Dissipation..... $I_{CC} = 4\mu\text{A}$  (Max.) at  $T_a = 25^\circ\text{C}$
- High Noise Immunity..... $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (Min.)
- Output drive Capability.....10 LSTTL Loads
- Symmetrical Output Impedance... $|I_{OH}| = I_{OL} = 4\text{mA}$  (Min.)
- Balanced Propagation Delays..... $t_{PLH} \approx t_{PHL}$
- Wide Operating Voltage Range... $V_{CC}$  (opr.) =  $2\text{V} \sim 6\text{V}$
- Pin and Function Compatible with 74LS191

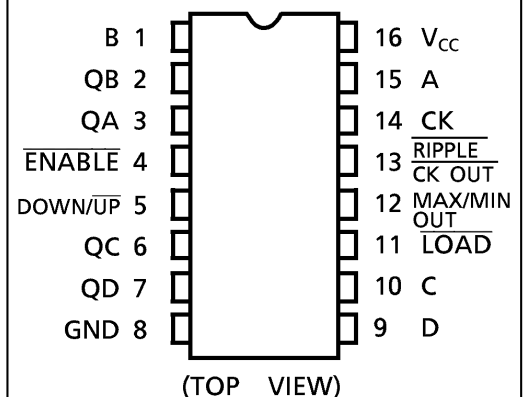


P (DIP16-P-300-2.54A)  
Weight : 1.00g (Typ.)

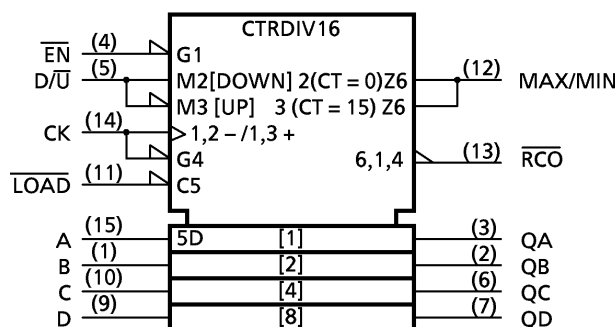


F (SOP16-P-300-1.27)  
Weight : 0.18g (Typ.)

### PIN ASSIGNMENT



### IEC LOGIC SYMBOL

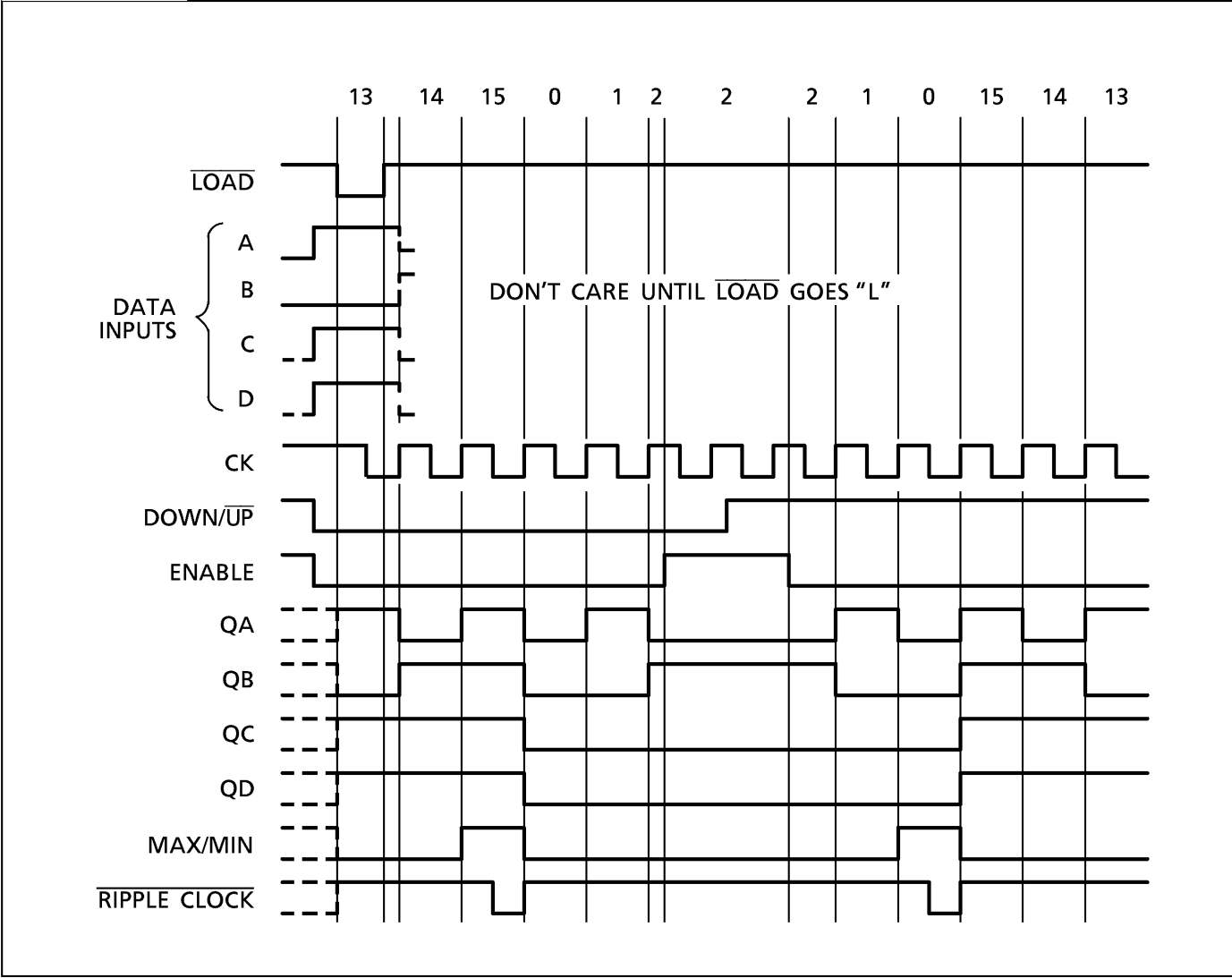


TRUTH TABLE

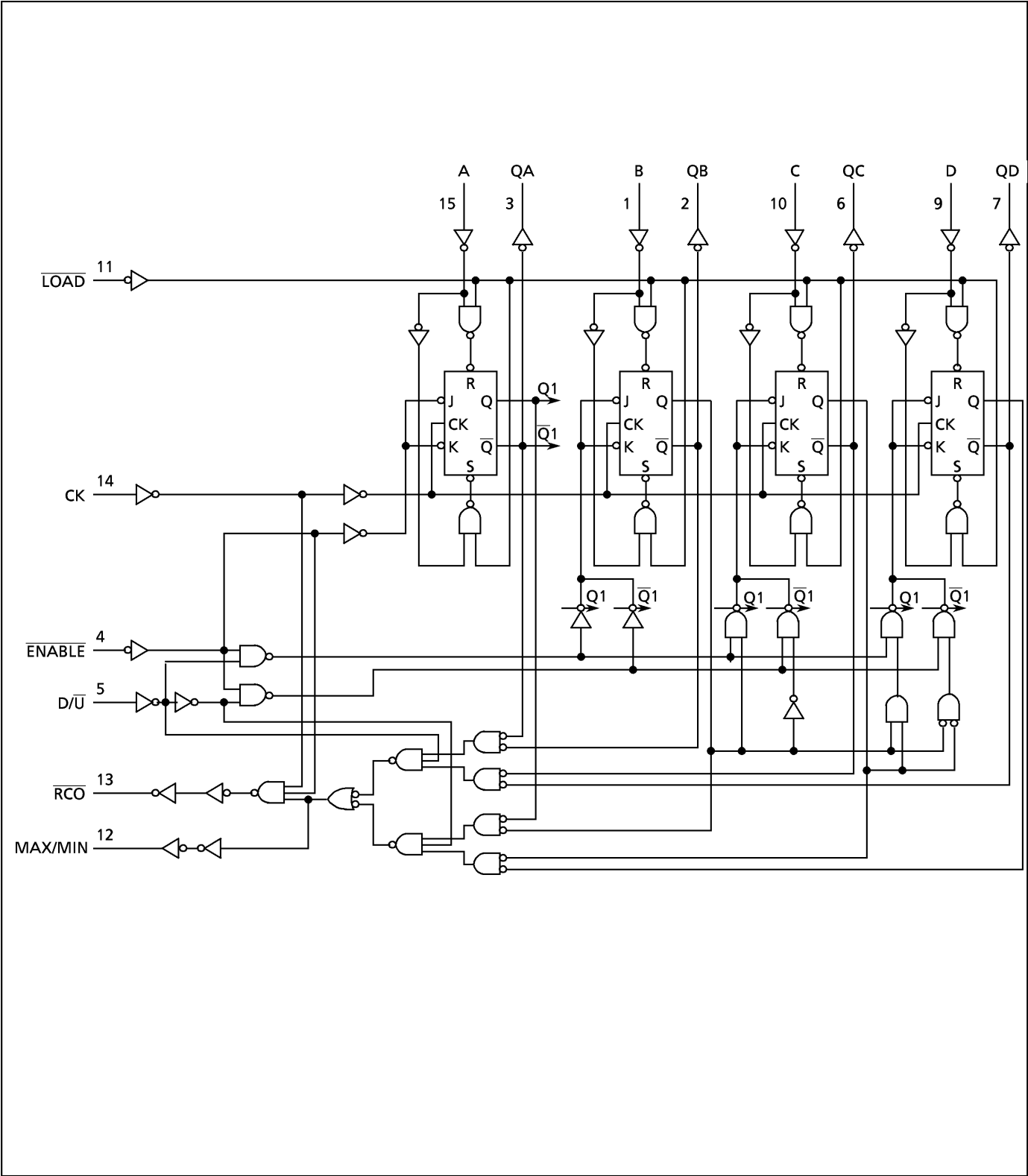
| INPUTS |        |     |    | OUTPUTS    |    |    |    | FUNCTION    |
|--------|--------|-----|----|------------|----|----|----|-------------|
| LOAD   | ENABLE | D/U | CK | QA         | QB | QC | QD |             |
| L      | X      | X   | X  | a          | b  | c  | d  | PRESET DATA |
| H      | L      | L   | ⏚  | UP COUNT   |    |    |    | UP COUNT    |
| H      | L      | H   | ⏚  | DOWN COUNT |    |    |    | DOWN COUNT  |
| H      | H      | X   | ⏚  | NO CHANGE  |    |    |    | NO COUNT    |
| H      | X      | X   | ⏚  | NO CHANGE  |    |    |    | NO COUNT    |

NOTE X : DON'T CARE  
a ~ d : Inputs Level of A ~ D

TIMING CHART



SYSTEM DIAGRAM



## 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                      | 4.18              | 4.31                 | —                                 | 4.13                 |               |
|                             |          |                                      | $I_{OH} = -5.2 \text{ mA}$ | 6.0                      | 5.68              | 5.80                 | —                                 | 5.63                 |               |
| 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>0.0    | —<br>—<br>—                       | 0.1<br>0.1<br>0.1    | V             |
|                             |          |                                      | $I_{OL} = 4 \text{ mA}$    | 4.5                      | —                 | 0.17                 | —                                 | 0.33                 |               |
|                             |          |                                      | $I_{OL} = 5.2 \text{ mA}$  | 6.0                      | —                 | 0.18                 | —                                 | 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 | $V_{CC}(\text{V})$ | $T_a = 25^\circ\text{C}$ |       | $T_a = -40\sim 85^\circ\text{C}$ | UNIT |
|----------------------------------------------------------------------------------|--------------------------|----------------|--------------------|--------------------------|-------|----------------------------------|------|
|                                                                                  |                          |                |                    | TYP.                     | LIMIT | LIMIT                            |      |
| Minimum Pulse Width<br>( CK )                                                    | $t_{W(H)}$<br>$t_{W(L)}$ |                | 2.0                | —                        | 100   | 125                              | ns   |
|                                                                                  |                          |                | 4.5                | —                        | 20    | 25                               |      |
|                                                                                  |                          |                | 6.0                | —                        | 17    | 21                               |      |
| Minimum Pulse Width<br>( LOAD )                                                  | $t_{W(L)}$               |                | 2.0                | —                        | 75    | 95                               |      |
|                                                                                  |                          |                | 4.5                | —                        | 15    | 19                               |      |
|                                                                                  |                          |                | 6.0                | —                        | 13    | 16                               |      |
| Minimum Set-up Time<br>( $\overline{\text{ENABLE}}$ , D/ $\overline{\text{U}}$ ) | $t_s$                    |                | 2.0                | —                        | 150   | 190                              |      |
|                                                                                  |                          |                | 4.5                | —                        | 30    | 38                               |      |
|                                                                                  |                          |                | 6.0                | —                        | 26    | 33                               |      |
| Minimum Set-up Time<br>( DATA—LOAD )                                             | $t_s$                    |                | 2.0                | —                        | 50    | 65                               |      |
|                                                                                  |                          |                | 4.5                | —                        | 10    | 13                               |      |
|                                                                                  |                          |                | 6.0                | —                        | 9     | 11                               |      |
| Minimum Hold Time<br>( $\overline{\text{ENABLE}}$ , D/ $\overline{\text{U}}$ )   | $t_h$                    |                | 2.0                | —                        | 0     | 0                                |      |
|                                                                                  |                          |                | 4.5                | —                        | 0     | 0                                |      |
|                                                                                  |                          |                | 6.0                | —                        | 0     | 0                                |      |
| Minimum Hold Time<br>( DATA—LOAD )                                               | $t_h$                    |                | 2.0                | —                        | 0     | 0                                |      |
|                                                                                  |                          |                | 4.5                | —                        | 0     | 0                                |      |
|                                                                                  |                          |                | 6.0                | —                        | 0     | 0                                |      |
| Minimum Removal Time                                                             | $t_{\text{rem}}$         |                | 2.0                | —                        | 50    | 65                               |      |
|                                                                                  |                          |                | 4.5                | —                        | 10    | 13                               |      |
|                                                                                  |                          |                | 6.0                | —                        | 9     | 11                               |      |
| Clock Frequency                                                                  | f                        |                | 2.0                | —                        | 5     | 4                                | MHz  |
|                                                                                  |                          |                | 4.5                | —                        | 25    | 20                               |      |
|                                                                                  |                          |                | 6.0                | —                        | 29    | 24                               |      |

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>$t_{THL}$ |                | —    | 4    | 8    | ns   |
| Propagation Delay Time<br>( CK—Q )        | $t_{PLH}$<br>$t_{PHL}$ |                | —    | 18   | 31   |      |
| Propagation Delay Time<br>( CK—RCO )      | $t_{PLH}$<br>$t_{PHL}$ |                | —    | 10   | 20   |      |
| Propagation Delay Time<br>( CK—MAX/MIN )  | $t_{PLH}$<br>$t_{PHL}$ |                | —    | 23   | 42   |      |
| Propagation Delay Time<br>( LOAD—Q )      | $t_{PLH}$<br>$t_{PHL}$ |                | —    | 21   | 35   |      |
| Propagation Delay Time<br>( DATA—Q )      | $t_{PLH}$<br>$t_{PHL}$ |                | —    | 17   | 30   |      |
| Propagation Delay Time<br>( ENABLE—RCO )  | $t_{PLH}$<br>$t_{PHL}$ |                | —    | 11   | 17   |      |
| Propagation Delay Time<br>( D/Ū—RCO )     | $t_{PLH}$<br>$t_{PHL}$ |                | —    | 17   | 31   |      |
| Propagation Delay Time<br>( D/Ū—MAX/MIN ) | $t_{PLH}$<br>$t_{PHL}$ |                | —    | 15   | 27   |      |
| Maximum Clock Frequency                   | $f_{MAX}$              |                | 27   | 48   | —    | MHz  |

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

| PARAMETER                                                                       | SYMBOL                 | TEST CONDITION | $V_{CC}(\text{V})$ | $T_a = 25^\circ\text{C}$ |      |      | $T_a = -40\sim 85^\circ\text{C}$ |      | UNIT |
|---------------------------------------------------------------------------------|------------------------|----------------|--------------------|--------------------------|------|------|----------------------------------|------|------|
|                                                                                 |                        |                |                    | MIN.                     | TYP. | MAX. | MIN.                             | MAX. |      |
| Output Transition Time                                                          | $t_{TLH}$<br>$t_{THL}$ |                | 2.0                | —                        | 30   | 75   | —                                | 95   | ns   |
|                                                                                 |                        |                | 4.5                | —                        | 8    | 15   | —                                | 19   |      |
|                                                                                 |                        |                | 6.0                | —                        | 7    | 13   | —                                | 16   |      |
| Propagation Delay Time<br>(CK—Q)                                                | $t_{pLH}$<br>$t_{pHL}$ |                | 2.0                | —                        | 88   | 180  | —                                | 225  |      |
|                                                                                 |                        |                | 4.5                | —                        | 22   | 36   | —                                | 45   |      |
|                                                                                 |                        |                | 6.0                | —                        | 19   | 31   | —                                | 38   |      |
| Propagation Delay Time<br>(CK— $\overline{\text{RCO}}$ )                        | $t_{pLH}$<br>$t_{pHL}$ |                | 2.0                | —                        | 52   | 120  | —                                | 150  |      |
|                                                                                 |                        |                | 4.5                | —                        | 13   | 24   | —                                | 30   |      |
|                                                                                 |                        |                | 6.0                | —                        | 11   | 20   | —                                | 26   |      |
| Propagation Delay Time<br>(CK—MAX/MIN)                                          | $t_{pLH}$<br>$t_{pHL}$ |                | 2.0                | —                        | 108  | 240  | —                                | 300  |      |
|                                                                                 |                        |                | 4.5                | —                        | 27   | 48   | —                                | 60   |      |
|                                                                                 |                        |                | 6.0                | —                        | 23   | 41   | —                                | 51   |      |
| Propagation Delay Time<br>(LOAD—Q)                                              | $t_{pLH}$<br>$t_{pHL}$ |                | 2.0                | —                        | 100  | 205  | —                                | 255  |      |
|                                                                                 |                        |                | 4.5                | —                        | 25   | 41   | —                                | 51   |      |
|                                                                                 |                        |                | 6.0                | —                        | 22   | 35   | —                                | 43   |      |
| Propagation Delay Time<br>(DATA—Q)                                              | $t_{pLH}$<br>$t_{pHL}$ |                | 2.0                | —                        | 84   | 175  | —                                | 220  |      |
|                                                                                 |                        |                | 4.5                | —                        | 21   | 35   | —                                | 44   |      |
|                                                                                 |                        |                | 6.0                | —                        | 18   | 30   | —                                | 37   |      |
| Propagation Delay Time<br>(ENABLE— $\overline{\text{RCO}}$ )                    | $t_{pLH}$<br>$t_{pHL}$ |                | 2.0                | —                        | 56   | 105  | —                                | 130  |      |
|                                                                                 |                        |                | 4.5                | —                        | 14   | 21   | —                                | 26   |      |
|                                                                                 |                        |                | 6.0                | —                        | 12   | 18   | —                                | 22   |      |
| Propagation Delay Time<br>( $\overline{\text{D/U}}$ — $\overline{\text{RCO}}$ ) | $t_{pLH}$<br>$t_{pHL}$ |                | 2.0                | —                        | 84   | 180  | —                                | 225  |      |
|                                                                                 |                        |                | 4.5                | —                        | 21   | 36   | —                                | 45   |      |
|                                                                                 |                        |                | 6.0                | —                        | 18   | 31   | —                                | 38   |      |
| Propagation Delay Time<br>( $\overline{\text{D/U}}$ —MAX/MIN)                   | $t_{pLH}$<br>$t_{pHL}$ |                | 2.0                | —                        | 72   | 160  | —                                | 200  |      |
|                                                                                 |                        |                | 4.5                | —                        | 18   | 32   | —                                | 40   |      |
|                                                                                 |                        |                | 6.0                | —                        | 15   | 27   | —                                | 34   |      |
| Maximum Clock Frequency                                                         | $f_{\text{MAX}}$       |                | 2.0                | 5                        | 11   | —    | 4                                | —    | MHz  |
|                                                                                 |                        |                | 4.5                | 25                       | 44   | —    | 20                               | —    |      |
|                                                                                 |                        |                | 6.0                | 29                       | 52   | —    | 24                               | —    |      |
| Input Capacitance                                                               | $C_{\text{IN}}$        |                |                    | —                        | 5    | 10   | —                                | 10   | pF   |
| Power Dissipation Capacitance                                                   | $C_{\text{PD}}(1)$     |                |                    | —                        | 101  | —    | —                                | —    |      |

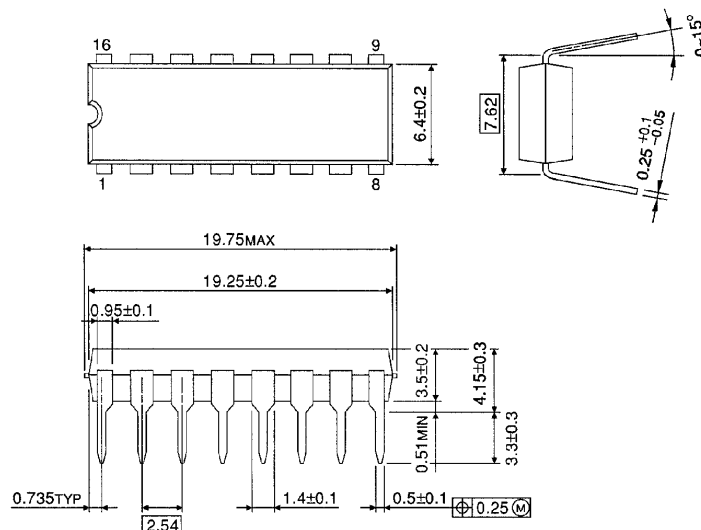
Note (1)  $C_{\text{PD}}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

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

## DIP 16PIN PACKAGE DIMENSIONS (DIP16-P-300-2.54A)

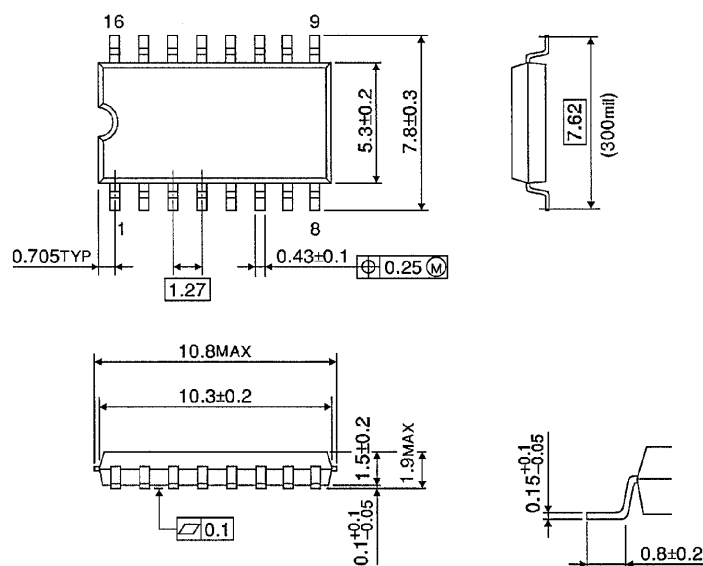
Unit in mm



Weight : 1.00g (Typ.)

## SOP 16PIN (200mil BODY) PACKAGE DIMENSIONS (SOP16-P-300-1.27)

Unit in mm



Weight : 0.18g (Typ.)

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000707EBA

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