

# TC74HC652AP

## OCTAL BUS TRANSCEIVER / REGISTER (3-STATE)

The TC74HC652A is high speed CMOS OCTAL BUS TRANSCEIVER/REGISTER fabricated with silicon gate CMOS technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

This device is bus transceiver with 3-state outputs, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the internal registers.

When the enable input  $\overline{GAB}$  and  $\overline{GBA}$  are held high, the A1 thru A8 become inputs and the B1 thru B8 become outputs. When the  $\overline{GAB}$  and  $\overline{GBA}$  are held low, the A1 thru A8 become output and the B1 thru B8 become inputs. When  $\overline{GAB}$  is low and  $\overline{GBA}$  is high, the outputs functions of the A and B Busses are disabled.

The select inputs (SAB, SBA) can multiplex stort and real-time (transparent mode) data.

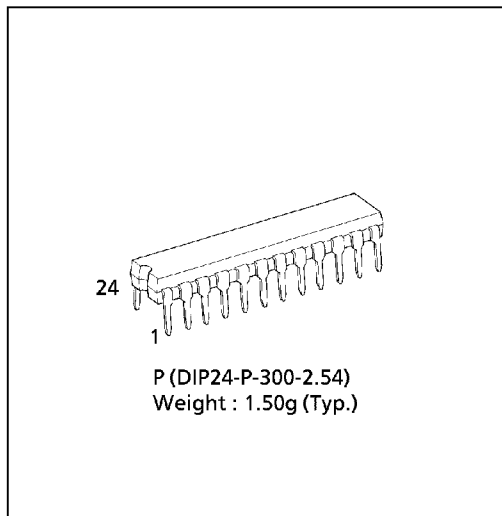
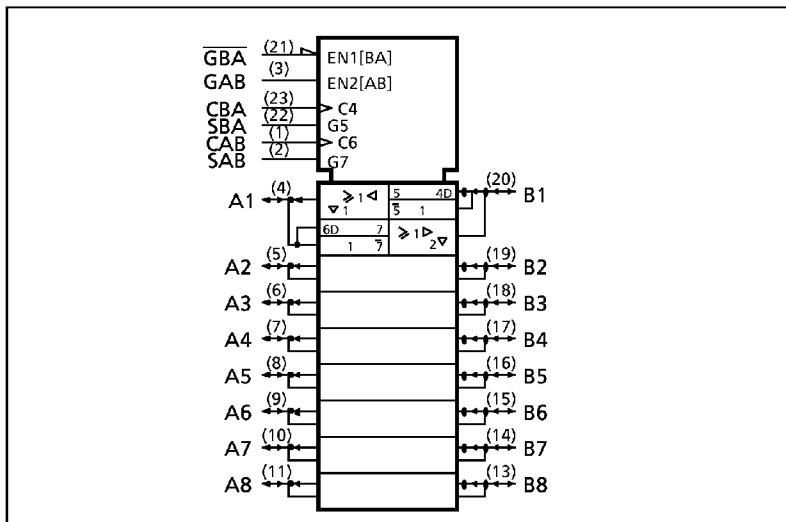
Data on the A Bus or B Bus can be clocked into the registers on the positive going transition of either CAB or CBA clock inputs, respectively.

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

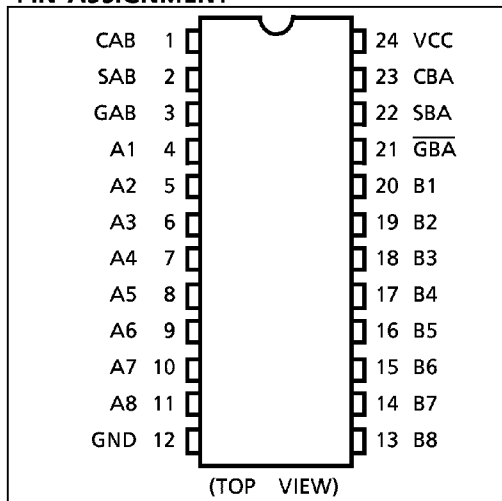
### FEATURES :

- High Speed.....  $f_{MAX} = 73\text{MHz}$  (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..... 15 LSTTL Loads
- Symmetrical Output Impedance...  $|I_{OH}| = I_{OL} = 6\text{mA}$  (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 74LS652

### IEC LOGIC SYSTEMBOL



### PIN ASSIGNMENT



### APPLICATION NOTES

- 1) Do not apply a signal to any bus terminal when it is in the output mode. Damage may result.
- 2) All floating (high impedance) bus terminals must have their input levels fixed by means of pull up or pull down resistors.

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TRUTH TABLE

| GAB | $\overline{G}A$ | CAB        | CBA        | SAB | SBA | A                 | B                 | Function   |
|-----|-----------------|------------|------------|-----|-----|-------------------|-------------------|--|
| L   | H               | X*         | X*         | X   | X   | INPUTS<br>Z       | INPUTS<br>Z       | The output functions of A and B Busses are disabled.   |
|     |                 | $\uparrow$ | $\uparrow$ | X   | X   | X                 | X                 | Both A and B Busses are used as inputs to the internal flip-flops. Data on the Bus will be stored on the rising edge of the Clock.               |
| L   | L               | X*         | X*         | X   | L   | OUTPUTS<br>L<br>H | INPUTS<br>L<br>H  | The data on the B bus are displayed on the A bus.  |
|     |                 | X*         | $\uparrow$ | X   | L   | L<br>H            | L<br>H            | The data on the B Bus are displayed on the A Bus, and are stored into the B storage flip-flops on the rising edge of CBA.                        |
|     |                 | X*         | X*         | X   | H   | Qn                | X                 | The data in the B storage flip-flops are displayed on the A Bus.   |
|     |                 | X*         | $\uparrow$ | X   | H   | L<br>H            | L<br>H            | The data on the B Bus are stored into the B storage flip-flops on the rising edge of CBA, and the stored data propagate directly onto the A Bus. |
| H   | H               | X*         | X*         | L   | X   | INPUTS<br>L<br>H  | OUTPUTS<br>L<br>H | The data on the A bus are displayed on the B bus.  |
|     |                 | $\uparrow$ | X*         | L   | X   | L<br>H            | L<br>H            | The data on the A Bus are displayed on the B Bus, and are stored into the A storage flip-flops on the rising edge of CAB.                        |
|     |                 | X*         | X*         | H   | X   | X                 | Qn                | The data in the A storage flip-flops are displayed on the B Bus.   |
|     |                 | $\uparrow$ | X*         | H   | X   | L<br>H            | L<br>H            | The data on the A Bus are stored into the A storage flip-flops on the rising edge of CAB, and the stored data propagate directly onto the B Bus. |
| H   | L               | X*         | X*         | H   | H   | OUTPUTS<br>Qn     | OUTPUTS<br>Qn     | The data in the A storage flip-flops are displayed on the B Bus, and the data in the B storage flip-flops are displayed on the A                 |

Notes : X : Don't Care

Qn : The data stored into the internal flip-flops by most recent low to high transition of the clock inputs.

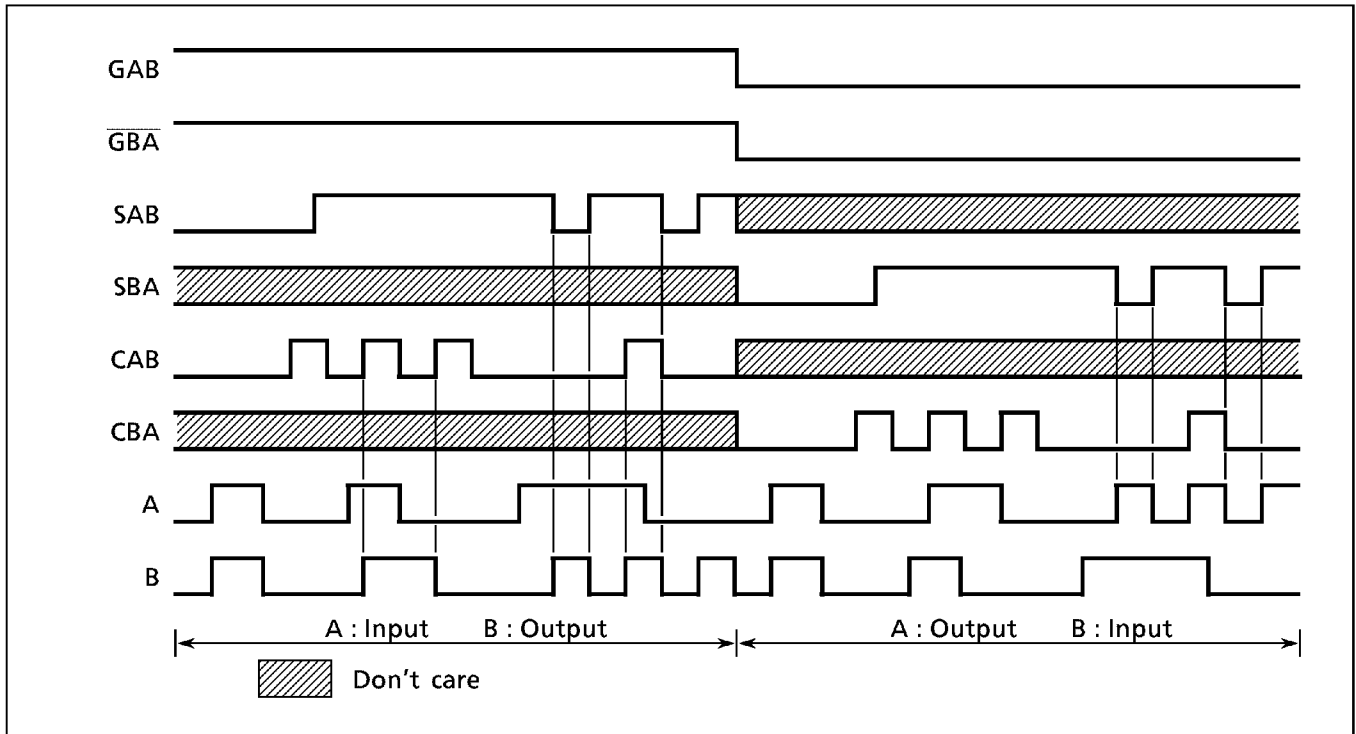
Z : High Impedance

\* The clocks are not internally gated with either Output Enable or Select Inputs. Therefore, data on the A and/or B Busses may be clocked into the storage flip-flops at any time.

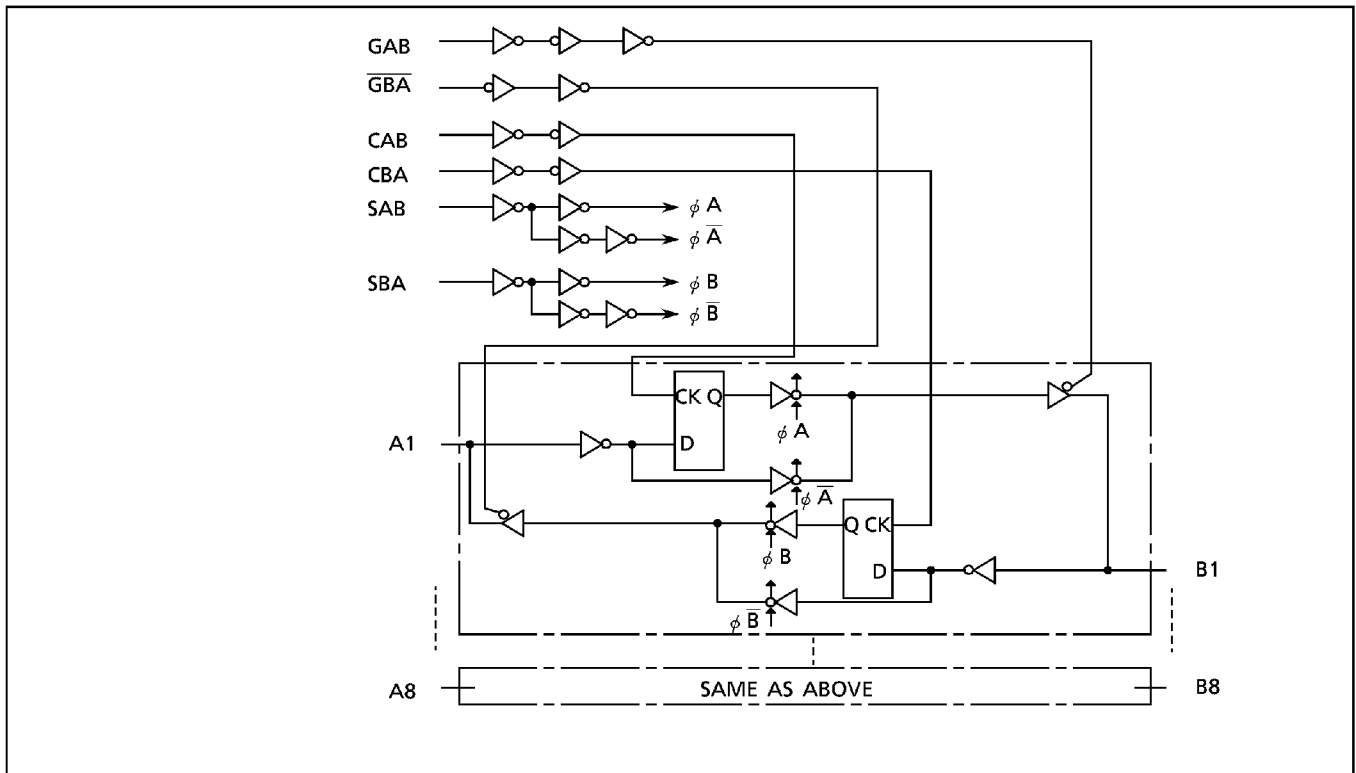
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TIMING CHART



SYSTEM DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

| PARAMETER                   | SYMBOL    | VALUE                | UNIT |
|-----------------------------|-----------|----------------------|------|
| Supply Voltage Range        | $V_{CC}$  | -0.5~7               | V    |
| DC Input Voltage            | $V_{IN}$  | -0.5~ $V_{CC} + 0.5$ | V    |
| DC Output Voltage           | $V_{OUT}$ | -0.5~ $V_{CC} + 0.5$ | V    |
| Input Diode Current         | $I_{IK}$  | ±20                  | mA   |
| Output Diode Current        | $I_{OK}$  | ±20                  | mA   |
| DC Output Current           | $I_{OUT}$ | ±35                  | mA   |
| DC $V_{CC}$ /Ground Current | $I_{CC}$  | ±75                  | mA   |
| Power Dissipation           | $P_D$     | 500*                 | mW   |
| Storage Temperature         | $T_{stg}$ | -65~150              | °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           | $V_{CC}$   | 2~6   | V    |
| Input Voltage            | $V_{IN}$   | 0~ $V_{CC}$   | V    |
| Output Voltage           | $V_{OUT}$  | 0~ $V_{CC}$   | V    |
| Operating Temperature    | $T_{opr}$  | -40~85  | °C   |
| Input Rise and Fall Time | $t_r, t_f$ | 0~1000 ( $V_{CC} = 2.0\text{V}$ )<br>0~500 ( $V_{CC} = 4.5\text{V}$ )<br>0~400 ( $V_{CC} = 6.0\text{V}$ ) | 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          | $V_{OH}$ | $V_{IN} = V_{IH}$ or $V_{IL}$                              | $I_{OH} = -20\mu\text{A}$ | 2.0                        | 1.9         | 2.0                  | —                                   | 1.9                  | —    | V                     |          |                          |     |   |   |      |   |      |
|                                      |          |  |                           | 4.5                        | 4.4         | 4.5                  | —                                   | 4.4                  | —    |                       |          |                          |     |   |   |      |   |      |
|                                      |          |  |                           | 6.0                        | 5.9         | 6.0                  | —                                   | 5.9                  | —    |                       |          |                          |     |   |   |      |   |      |
| Low - Level Output Voltage           | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$                              | $I_{OL} = 20\mu\text{A}$  | 2.0                        | —           | 0.0                  | 0.1                                 | —                    | 0.1  | V                     |          |                          |     |   |   |      |   |      |
|                                      |          |  |                           | 4.5                        | —           | 0.0                  | 0.1                                 | —                    | 0.1  |                       |          |                          |     |   |   |      |   |      |
|                                      |          |  |                           | 6.0                        | —           | 0.0                  | 0.1                                 | —                    | 0.1  |                       |          |                          |     |   |   |      |   |      |
| 3 - State Output Off - State Current | $I_{OZ}$ | $V_{IN} = V_{IH}$ or $V_{IL}$<br>$V_{OUT} = V_{CC}$ or GND | 6.0                       | —                          | —           | ±0.5                 | —                                   | ±5.0                 | μA   |                       |          |                          |     |   |   |      |   |      |
|                                      |          |  |                           |                            |             |                      |                                     |                      |      | Input Leakage Current | $I_{IN}$ | $V_{IN} = V_{CC}$ or GND | 6.0 | — | — | ±0.1 | — | ±1.0 |
|                                      |          |  |                           |                            |             |                      |                                     |                      |      |                       |          |                          |     |   |   |      |   |      |

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<br>(CK) | $t_{w(L)}$<br>$t_{w(H)}$ |                | 2.0          | —                        | 75    | 95                                | ns   |
|                             |                          |                | 4.5          | —                        | 15    | 19                                |      |
|                             |                          |                | 6.0          | —                        | 13    | 16                                |      |
| Minimum Set-up Time         | $t_s$                    |                | 2.0          | —                        | 50    | 65                                |      |
|                             |                          |                | 4.5          | —                        | 10    | 13                                |      |
|                             |                          |                | 6.0          | —                        | 9     | 11                                |      |
| Minimum Hold Time           | $t_h$                    |                | 2.0          | —                        | 5     | 5                                 |      |
|                             |                          |                | 4.5          | —                        | 5     | 5                                 |      |
|                             |                          |                | 6.0          | —                        | 5     | 5                                 |      |
| Clock Frequency             | f                        |                | 2.0          | —                        | 6     | 5                                 |      |
|                             |                          |                | 4.5          | —                        | 31    | 25                                |      |
|                             |                          |                | 6.0          | —                        | 36    | 29                                |      |

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

| PARAMETER  | SYMBOL                 | TEST CONDITION          | CL (pF) | $V_{CC}$ (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>$t_{THL}$ |                         | 50      | 2.0          | —                        | 25   | 60   | —                                 | 75   | ns   |
|  |                        |                         |         | 4.5          | —                        | 7    | 12   | —                                 | 15   |      |
|  |                        |                         |         | 6.0          | —                        | 6    | 10   | —                                 | 13   |      |
| Propagation Delay Time<br>(BUS—BUS)                            | $t_{pLH}$              |                         | 50      | 2.0          | —                        | 74   | 150  | —                                 | 190  |      |
|  |                        |                         |         | 4.5          | —                        | 21   | 30   | —                                 | 38   |      |
|  |                        |                         |         | 6.0          | —                        | 18   | 26   | —                                 | 32   |      |
|  | $t_{pHL}$              |                         | 150     | 2.0          | —                        | 91   | 190  | —                                 | 240  |      |
|  |                        |                         |         | 4.5          | —                        | 26   | 38   | —                                 | 48   |      |
|  |                        |                         |         | 6.0          | —                        | 22   | 32   | —                                 | 41   |      |
| Propagation Delay Time<br>(CAB, CBA—BUS)                       | $t_{pLH}$              |                         | 50      | 2.0          | —                        | 98   | 210  | —                                 | 265  |      |
|  |                        |                         |         | 4.5          | —                        | 28   | 42   | —                                 | 53   |      |
|  |                        |                         |         | 6.0          | —                        | 24   | 36   | —                                 | 45   |      |
|  | $t_{pHL}$              |                         | 150     | 2.0          | —                        | 116  | 250  | —                                 | 315  |      |
|  |                        |                         |         | 4.5          | —                        | 33   | 50   | —                                 | 63   |      |
|  |                        |                         |         | 6.0          | —                        | 28   | 43   | —                                 | 54   |      |
| Propagation Delay Time<br>(SAB, SBA—BUS)                       | $t_{pLH}$              |                         | 50      | 2.0          | —                        | 81   | 170  | —                                 | 215  |      |
|  |                        |                         |         | 4.5          | —                        | 23   | 34   | —                                 | 43   |      |
|  |                        |                         |         | 6.0          | —                        | 20   | 29   | —                                 | 37   |      |
|  | $t_{pHL}$              |                         | 150     | 2.0          | —                        | 98   | 210  | —                                 | 265  |      |
|  |                        |                         |         | 4.5          | —                        | 28   | 42   | —                                 | 53   |      |
|  |                        |                         |         | 6.0          | —                        | 24   | 36   | —                                 | 45   |      |
| Propagation Enable Time<br>(GAB, $\overline{\text{GBA}}$ —BUS) | $t_{pZL}$              | $R_L = 1\text{k}\Omega$ | 50      | 2.0          | —                        | 74   | 175  | —                                 | 220  |      |
|  |                        |                         |         | 4.5          | —                        | 21   | 35   | —                                 | 44   |      |
|  |                        |                         |         | 6.0          | —                        | 18   | 30   | —                                 | 37   |      |
|  | $t_{pZH}$              |                         | 150     | 2.0          | —                        | 91   | 215  | —                                 | 270  |      |
|  |                        |                         |         | 4.5          | —                        | 26   | 43   | —                                 | 54   |      |
|  |                        |                         |         | 6.0          | —                        | 22   | 37   | —                                 | 46   |      |
| Output Disable time<br>(GAB, $\overline{\text{GBA}}$ —BUS)     | $t_{pLZ}$<br>$t_{pHZ}$ | $R_L = 1\text{k}\Omega$ | 50      | 2.0          | —                        | 50   | 175  | —                                 | 220  |      |
|  |                        |                         |         | 4.5          | —                        | 21   | 35   | —                                 | 44   |      |
|  |                        |                         |         | 6.0          | —                        | 18   | 30   | —                                 | 37   |      |

AC ELECTRICAL CHARACTERISTICS ( Input  $t_r = t_f = 6\text{ns}$  ) (Cont'd)

| PARAMETER                     | SYMBOL              | TEST CONDITION | CL<br>(pF) | V <sub>CC</sub><br>(V) | Ta = 25°C     |                |             | Ta = -40~85°C |             | UNIT |
|-------------------------------|---------------------|----------------|------------|------------------------|---------------|----------------|-------------|---------------|-------------|------|
|                               |                     |                |            |                        | MIN.          | TYP.           | MAX.        | MIN.          | MAX.        |      |
| Maximum Clock Frequency       | f <sub>MAX</sub>    |                | 50         | 2.0<br>4.5<br>6.0      | 6<br>31<br>36 | 19<br>67<br>79 | —<br>—<br>— | 5<br>25<br>29 | —<br>—<br>— | MHz  |
| Input Capacitance             | C <sub>IN</sub>     |                |            |                        | —             | 5              | 10          | —             | 10          | pF   |
| Output Capacitance            | C <sub>OUT</sub>    |                |            |                        | —             | 13             | —           | —             | —           |      |
| Power Dissipation Capacitance | C <sub>PD</sub> (1) |                |            |                        | —             | 39             | —           | —             | —           |      |

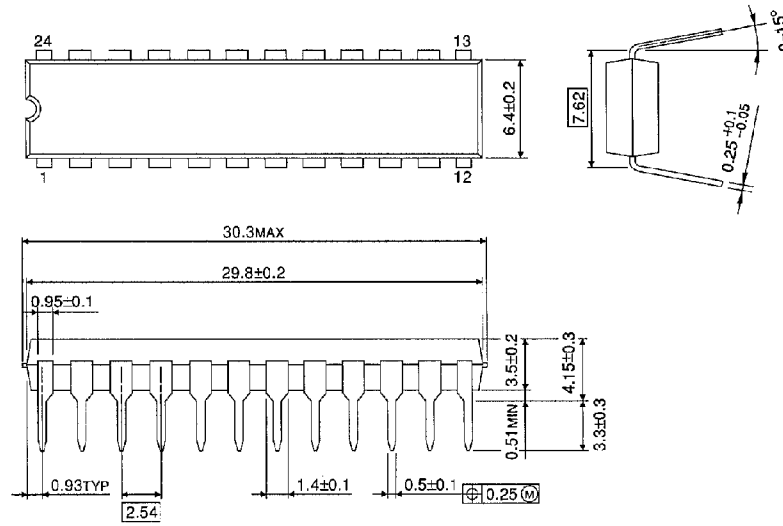
Note (1) C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

$$I_{CC}(\text{opr}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC} / 8 \text{ (per bit)}$$

DIP 24PIN OUTLINE DRAWING (DIP24-P-300-2.54)

Unit in mm



Weight : 1.50g (Typ.)