

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# 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.

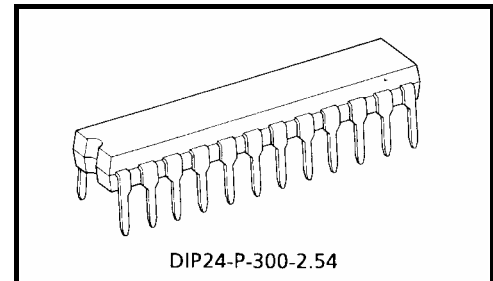
This device is bus transceiver with 3-state outputs, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the internal registers.

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 ( $\overline{SAB}$ ,  $\overline{SBA}$ ) can multiplex sort 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  $\overline{CAB}$  or  $\overline{CBA}$  clock inputs, respectively.

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



Weight : 1.50 g (typ.)

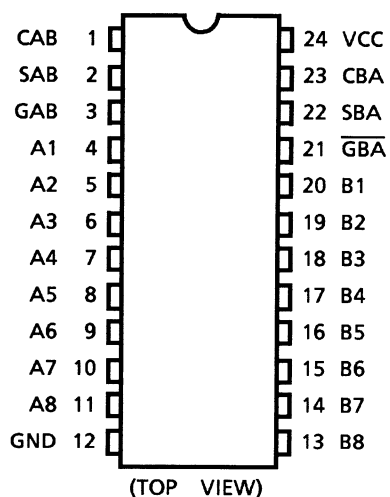
## Features (Note 1) (Note 2)

- 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:  $V_{CC}(\text{opr}) = 2 \text{ to } 6 \text{ V}$
- Pin and function compatible with 74LS652

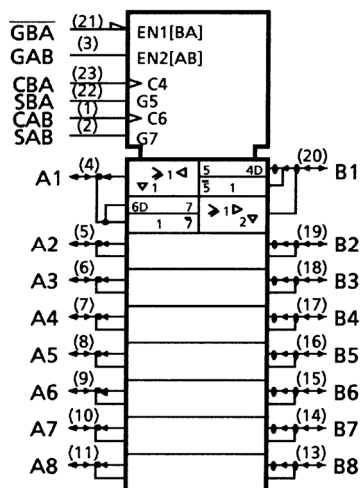
Note 1: Do not apply a signal to any bus terminal when it is in the output mode. Damage may result.

Note 2: All floating (high impedance) bus terminals must have their input levels fixed by means of pull up or pull down resistors.

## Pin Assignment



## IEC Logic Symbol



## Truth Table

| GAB | $\overline{\text{GBA}}$ | CAB                                                                                 | CBA                                                                               | SAB | SBA | A                 | B                 | Function                                                                                                                                         |
|-----|-------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----|-----|-------------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| L   | H                       | X<br>(Note)                                                                         | X<br>(Note)                                                                       | X   | X   | Inputs<br>Z       | Inputs<br>Z       | The output functions of A and B busses are disabled.                                                                                             |
|     |                         |    |  | 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<br>(Note)                                                                         | X<br>(Note)                                                                       | 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<br>(Note)                                                                         |  | 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<br>(Note)                                                                         | X<br>(Note)                                                                       | X   | H   | Qn                | X                 | The data in the B storage flip-flops are displayed on the A bus.                                                                                 |
|     |                         | X<br>(Note)                                                                         |  | 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<br>(Note)                                                                         | X<br>(Note)                                                                       | L   | X   | Inputs<br>L<br>H  | Outputs<br>L<br>H | The data on the A bus are displayed on the B bus.                                                                                                |
|     |                         |   | X<br>(Note)                                                                       | 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<br>(Note)                                                                         | X<br>(Note)                                                                       | H   | X   | X                 | Qn                | The data in the A storage flip-flops are displayed on the B bus.                                                                                 |
|     |                         |  | X<br>(Note)                                                                       | 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<br>(Note)                                                                         | X<br>(Note)                                                                       | 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.                |

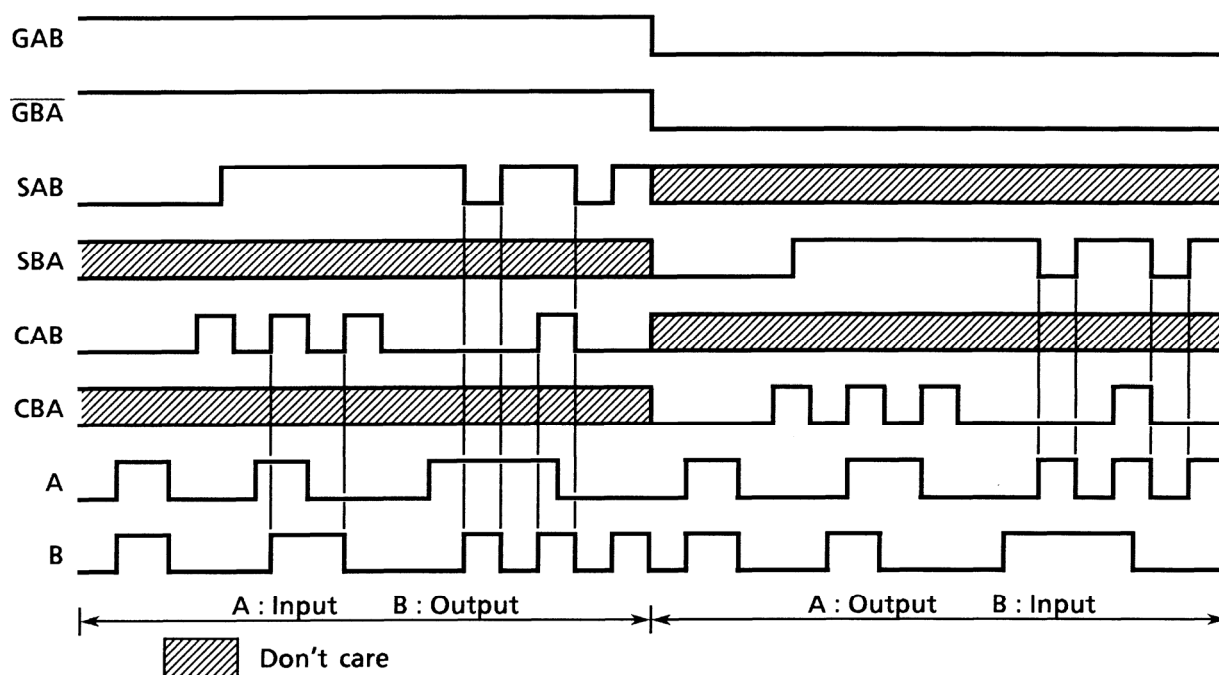
X: Don't care

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

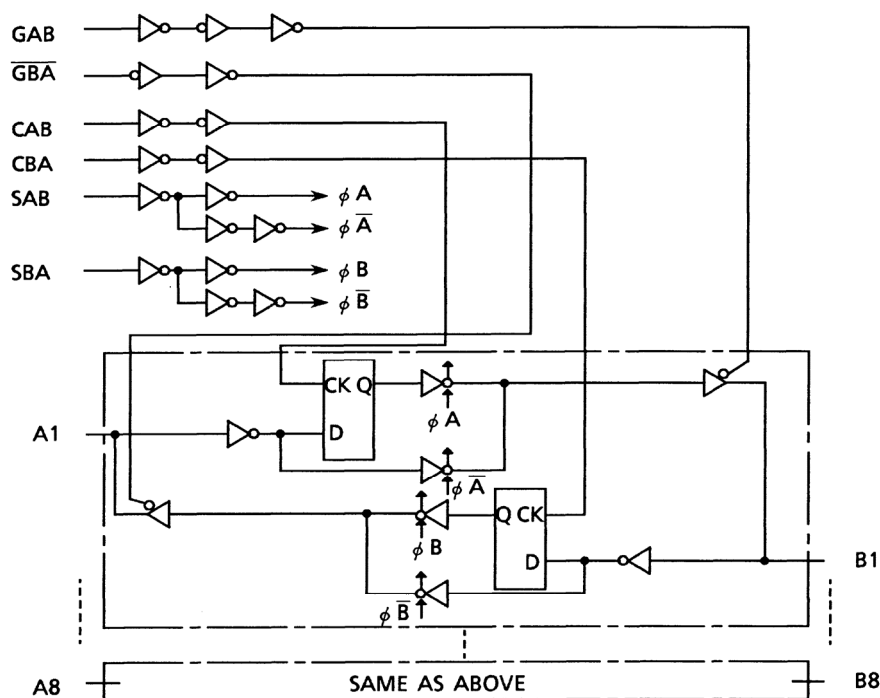
Z: High impedance

Note: 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.

## Timing Chart



## System Diagram



## Absolute Maximum Ratings (Note 1)

| Characteristics             | Symbol    | Rating                 | Unit |
|-----------------------------|-----------|------------------------|------|
| Supply voltage range        | $V_{CC}$  | -0.5 to 7              | V    |
| DC input voltage            | $V_{IN}$  | -0.5 to $V_{CC} + 0.5$ | V    |
| DC output voltage           | $V_{OUT}$ | -0.5 to $V_{CC} + 0.5$ | V    |
| Input diode current         | $I_{IK}$  | $\pm 20$               | mA   |
| Output diode current        | $I_{OK}$  | $\pm 20$               | mA   |
| DC output current           | $I_{OUT}$ | $\pm 35$               | mA   |
| DC $V_{CC}$ /ground current | $I_{CC}$  | $\pm 75$               | mA   |
| Power dissipation           | $P_D$     | 500 (Note 2)           | mW   |
| Storage temperature         | $T_{stg}$ | -65 to 150             | °C   |

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc.).

Note 2: 500 mW in the range of  $T_a = -40$  to  $65^\circ\text{C}$ . From  $T_a = 65$  to  $85^\circ\text{C}$  a derating factor of  $-10\text{ mW}/^\circ\text{C}$  shall be applied until 300 mW.

## Operating Ranges (Note)

| Characteristics          | Symbol     | Rating                                                                                                                | Unit |
|--------------------------|------------|-----------------------------------------------------------------------------------------------------------------------|------|
| Supply voltage           | $V_{CC}$   | 2 to 6                                                                                                                | V    |
| Input voltage            | $V_{IN}$   | 0 to $V_{CC}$                                                                                                         | V    |
| Output voltage           | $V_{OUT}$  | 0 to $V_{CC}$                                                                                                         | V    |
| Operating temperature    | $T_{opr}$  | -40 to 85                                                                                                             | °C   |
| Input rise and fall time | $t_r, t_f$ | 0 to 1000 ( $V_{CC} = 2.0\text{ V}$ )<br>0 to 500 ( $V_{CC} = 4.5\text{ V}$ )<br>0 to 400 ( $V_{CC} = 6.0\text{ V}$ ) | ns   |

Note: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs must be tied to either VCC or GND.

## Electrical Characteristics

## DC Characteristics

| Characteristics                  | Symbol          | Test Condition                                                                                    |                                                      | Ta = 25°C           |                      |             | Ta = -40 to 85°C     |                      | Unit |     |
|----------------------------------|-----------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------|---------------------|----------------------|-------------|----------------------|----------------------|------|-----|
|                                  |                 |                                                                                                   |                                                      | V <sub>CC</sub> (V) | Min                  | Typ.        | Max                  | Min                  |      | Max |
| High-level input voltage         | V <sub>IH</sub> | —                                                                                                 |                                                      | 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 | V    |     |
| Low-level input voltage          | V <sub>IL</sub> | —                                                                                                 |                                                      | 2.0<br>4.5<br>6.0   | —<br>—<br>—          | —<br>—<br>— | 0.50<br>1.35<br>1.80 | —<br>—<br>—          | V    |     |
| High-level output voltage        | V <sub>OH</sub> | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                              | I <sub>OH</sub> = -20 μA                             | 2.0                 | 1.9                  | 2.0         | —                    | 1.9                  | —    | V   |
|                                  |                 |                                                                                                   |                                                      | 4.5                 | 4.4                  | 4.5         | —                    | 4.4                  | —    |     |
|                                  |                 |                                                                                                   | I <sub>OH</sub> = -6 mA<br>I <sub>OH</sub> = -7.8 mA | 4.5                 | 4.18                 | 4.31        | —                    | 4.13                 | —    |     |
|                                  |                 |                                                                                                   |                                                      | 6.0                 | 5.68                 | 5.80        | —                    | 5.63                 | —    |     |
| Low-level output voltage         | V <sub>OL</sub> | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                              | I <sub>OL</sub> = 20 μA                              | 2.0                 | —                    | 0.0         | 0.1                  | —                    | 0.1  | V   |
|                                  |                 |                                                                                                   |                                                      | 4.5                 | —                    | 0.0         | 0.1                  | —                    | 0.1  |     |
|                                  |                 |                                                                                                   | I <sub>OL</sub> = 6 mA<br>I <sub>OL</sub> = 7.8 mA   | 6.0                 | —                    | 0.0         | 0.1                  | —                    | 0.1  |     |
|                                  |                 |                                                                                                   |                                                      | 4.5                 | —                    | 0.17        | 0.26                 | —                    | 0.33 |     |
|                                  |                 |                                                                                                   | 6.0                                                  | —                   | 0.18                 | 0.26        | —                    | 0.33                 |      |     |
| 3-state output off-state current | I <sub>OZ</sub> | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>OUT</sub> = V <sub>CC</sub> or GND |                                                      | 6.0                 | —                    | —           | ±0.5                 | —                    | ±5.0 | μA  |
| Input leakage current            | I <sub>IN</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND                                                          |                                                      | 6.0                 | —                    | —           | ±0.1                 | —                    | ±1.0 | μA  |
| Quiescent supply current         | I <sub>CC</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND                                                          |                                                      | 6.0                 | —                    | —           | 4.0                  | —                    | 40.0 | μA  |

Timing Requirements (input: t<sub>r</sub> = t<sub>f</sub> = 6 ns)

| Characteristics          | Symbol                                   | Test Condition |  | Ta = 25°C           |      | Ta = -40 to 85°C | Unit |
|--------------------------|------------------------------------------|----------------|--|---------------------|------|------------------|------|
|                          |                                          |                |  | V <sub>CC</sub> (V) | Typ. | Limit            |      |
| Minimum pulse width (CK) | t <sub>W</sub> (L)<br>t <sub>W</sub> (H) | —              |  | 2.0                 | —    | 75               | 95   |
|                          |                                          |                |  | 4.5                 | —    | 15               | 19   |
|                          |                                          |                |  | 6.0                 | —    | 13               | 16   |
| Minimum set-up time      | t <sub>s</sub>                           | —              |  | 2.0                 | —    | 50               | 65   |
|                          |                                          |                |  | 4.5                 | —    | 10               | 13   |
|                          |                                          |                |  | 6.0                 | —    | 9                | 11   |
| Minimum hold time        | t <sub>h</sub>                           | —              |  | 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 Characteristics (input: $t_r = t_f = 6 \text{ ns}$ )

| Characteristics                                             | Symbol        | Test Condition |         |                   | Ta = 25°C   |              |                | Ta = -40 to 85°C |                | Unit |
|-------------------------------------------------------------|---------------|----------------|---------|-------------------|-------------|--------------|----------------|------------------|----------------|------|
|                                                             |               |                | CL (pF) | VCC (V)           | Min         | Typ.         | Max            | Min              | Max            |      |
| Output transition time                                      | tTLH<br>tTHL  | —              | 50      | 2.0<br>4.5<br>6.0 | —<br>—<br>— | 25<br>7<br>6 | 60<br>12<br>10 | —<br>—<br>—      | 75<br>15<br>13 | ns   |
| Propagation delay time (BUS-bus)                            | tpLH<br>tpHL  | —              | 50      | 2.0               | —           | 74           | 150            | —                | 190            | ns   |
|                                                             |               |                |         | 4.5               | —           | 21           | 30             | —                | 38             |      |
|                                                             |               |                |         | 6.0               | —           | 18           | 26             | —                | 32             |      |
|                                                             |               |                | 150     | 2.0               | —           | 91           | 190            | —                | 240            |      |
|                                                             |               |                |         | 4.5               | —           | 26           | 38             | —                | 48             |      |
|                                                             |               |                |         | 6.0               | —           | 22           | 32             | —                | 41             |      |
| Propagation delay time (CAB, CBA-bus)                       | tpLH<br>tpHL  | —              | 50      | 2.0               | —           | 98           | 210            | —                | 265            | ns   |
|                                                             |               |                |         | 4.5               | —           | 28           | 42             | —                | 53             |      |
|                                                             |               |                |         | 6.0               | —           | 24           | 36             | —                | 45             |      |
|                                                             |               |                | 150     | 2.0               | —           | 116          | 250            | —                | 315            |      |
|                                                             |               |                |         | 4.5               | —           | 33           | 50             | —                | 63             |      |
|                                                             |               |                |         | 6.0               | —           | 28           | 43             | —                | 54             |      |
| Propagation delay time (SAB, SBA-bus)                       | tpLH<br>tpHL  | —              | 50      | 2.0               | —           | 81           | 170            | —                | 215            | ns   |
|                                                             |               |                |         | 4.5               | —           | 23           | 34             | —                | 43             |      |
|                                                             |               |                |         | 6.0               | —           | 20           | 29             | —                | 37             |      |
|                                                             |               |                | 150     | 2.0               | —           | 98           | 210            | —                | 265            |      |
|                                                             |               |                |         | 4.5               | —           | 28           | 42             | —                | 53             |      |
|                                                             |               |                |         | 6.0               | —           | 24           | 36             | —                | 45             |      |
| Propagation enable time (GAB, $\overline{\text{GBA}}$ -bus) | tpZL<br>tpZH  | RL = 1 kΩ      | 50      | 2.0               | —           | 74           | 175            | —                | 220            | ns   |
|                                                             |               |                |         | 4.5               | —           | 21           | 35             | —                | 44             |      |
|                                                             |               |                |         | 6.0               | —           | 18           | 30             | —                | 37             |      |
|                                                             |               |                | 150     | 2.0               | —           | 91           | 215            | —                | 270            |      |
|                                                             |               |                |         | 4.5               | —           | 26           | 43             | —                | 54             |      |
|                                                             |               |                |         | 6.0               | —           | 22           | 37             | —                | 46             |      |
| Output disable time (GAB, $\overline{\text{GBA}}$ -bus)     | tpLZ<br>tpHZ  | RL = 1 kΩ      | 50      | 2.0               | —           | 50           | 175            | —                | 220            | ns   |
|                                                             |               |                |         | 4.5               | —           | 21           | 35             | —                | 44             |      |
|                                                             |               |                |         | 6.0               | —           | 18           | 30             | —                | 37             |      |
| Maximum clock frequency                                     | fmax          | —              | 50      | 2.0               | 6           | 19           | —              | 5                | —              | MHz  |
|                                                             |               |                |         | 4.5               | 31          | 67           | —              | 25               | —              |      |
|                                                             |               |                |         | 6.0               | 36          | 79           | —              | 29               | —              |      |
| Input capacitance                                           | CIN           | —              |         |                   | —           | 5            | 10             | —                | 10             | pF   |
| Output capacitance                                          | COUT          | —              |         |                   | —           | 13           | —              | —                | —              | pF   |
| Power dissipation capacitance                               | CPD<br>(Note) | —              |         |                   | —           | 39           | —              | —                | —              | pF   |

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

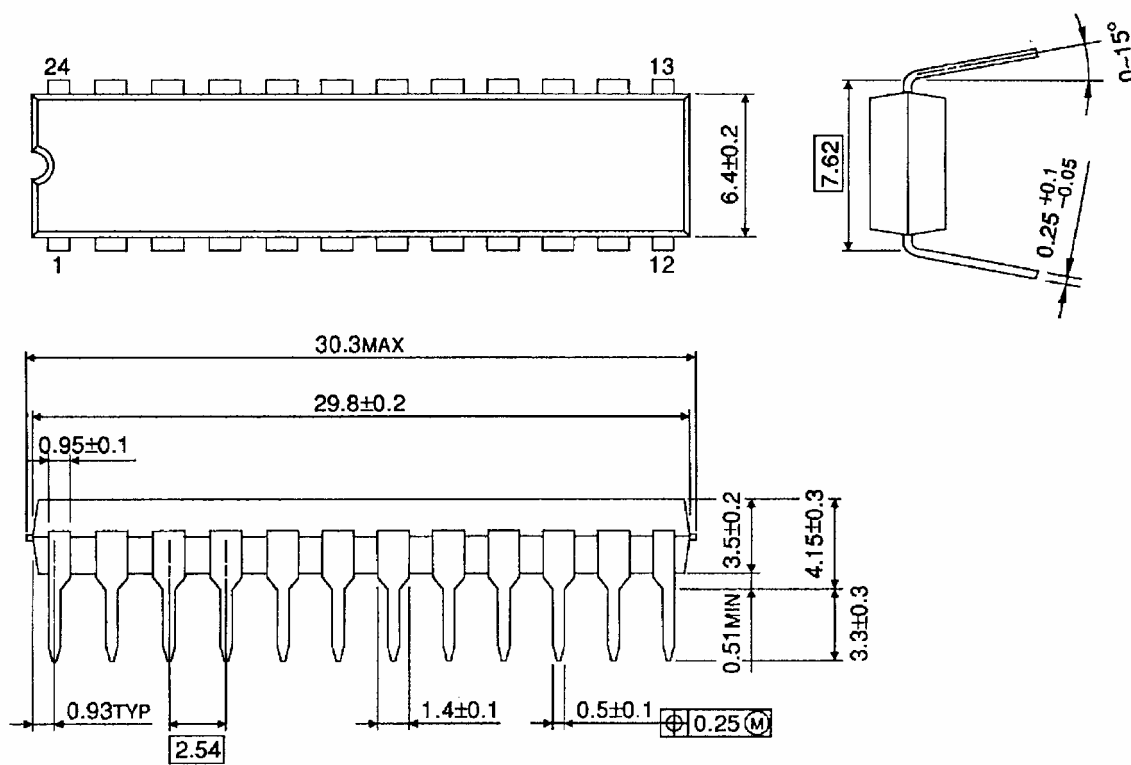
Average operating current can be obtained by the equation:

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

## Package Dimensions

DIP24-P-300-2.54

Unit : mm



Weight: 1.50 g (typ.)

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20070701-EN GENERAL

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