

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

**TC74LCXR163245FT****16-BIT DUAL SUPPLY VOLTAGE****INTERFACE BUS TRANSCEIVER WITH SERIES RESISTOR**

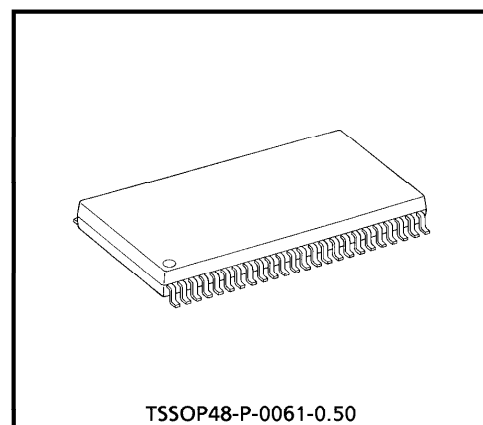
The TC74LCXR163245 is a dual supply, advanced high speed CMOS 16 bit DUAL SUPPLY VOLTAGE INTERFACE BUS TRANSCEIVER fabricated with silicon gate CMOS technology.

Designed for use as an interface between a 3.3 V or 2.5 V bus and a 5 V bus in mixed 3.3 V or 2.5 V/5 V supply systems' it achieves high speed operation while maintaining the CMOS low power dissipation.

It is intended for 2 way asynchronous communication between data busses. The direction of data transmission is determined by the level of the DIR input. The enable input ( $\overline{OE}$ ) can be used to disable the device so that the busses are effectively isolated. The B-port interfaces with the 3 V or 2.5 V bus, the A-port with the 5 V bus.

The 26- $\Omega$  series resistor helps reducing output overshoot and undershoot without external resistor.

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



Weight : 0.25 g (Typ.)

**FEATURES**

- 26- $\Omega$  series resistors on outputs
- Bidirectional interface between 3.3 V or 2.5 V and 5 V buses
- High speed :  $t_{pd} = 8.5 \text{ ns (max)}$   
( $V_{CCB} = 3.3 \pm 0.3 \text{ V} / V_{CCA} = 5 \pm 0.5 \text{ V}$ ,  $T_a = -40 \sim 85^\circ\text{C}$ )
- Low power dissipation :  $I_{CC} = 80 \mu\text{A (max)}$  ( $T_a = -40 \sim 85^\circ\text{C}$ )
- Symmetrical output impedance :  $I_{OUTB} = \pm 12 \text{ mA (min)}$   
 $I_{OUTA} = \pm 12 \text{ mA (min)}$   
( $V_{CCB} = 3.0 \text{ V} / V_{CCA} = 4.5 \text{ V}$ )
- Power Down Protection is provided on all inputs and outputs.
- Allows A port and  $V_{CCA}$  to float simultaneously when  $\overline{OE}$  is "H".
- Latch-up Performance :  $\pm 300 \text{ mA}$
- ESD Performance : Machine Model  $> \pm 200 \text{ V}$  (Note 2)
- Package : TSSOP (Thin Shrink Small Outline Package)

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

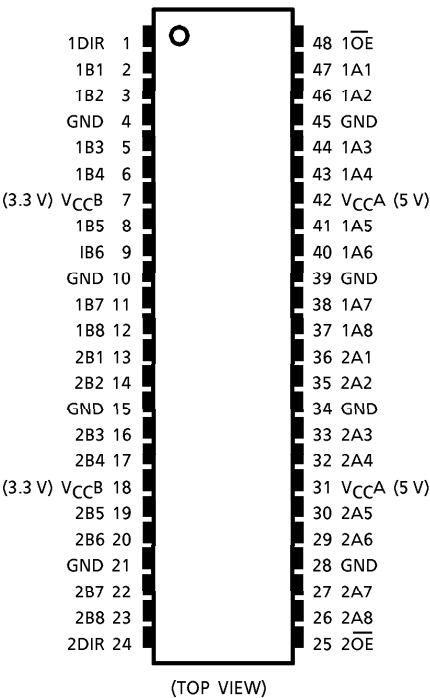
All floating (high impedance) bus terminals must have their input fixed by means of pull up or pull down resistors.

(Note 2) : This device is electrostatic sensitivity (Human Body Model  $> 1 \text{ kV}$ ). Please handle with caution.

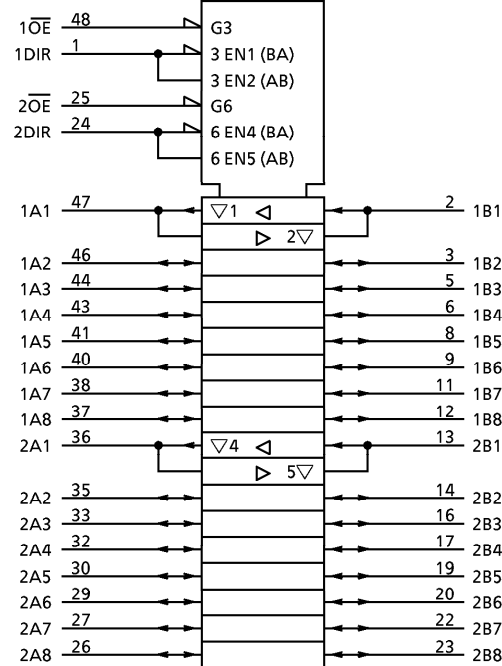
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PIN CONNECTION



IEC LOGIC SYMBOL



TRUTH TABLE

| INPUT |      | FUNCTION       |             | OUTPUT |
|-------|------|----------------|-------------|--------|
| 1OE   | 1DIR | BUS 1A1-1A8    | BUS 1B1-1B8 |        |
| L     | L    | OUTPUT         | INPUT       | A = B  |
| L     | H    | INPUT          | OUTPUT      | B = A  |
| H     | X    | High Impedance |             | Z      |

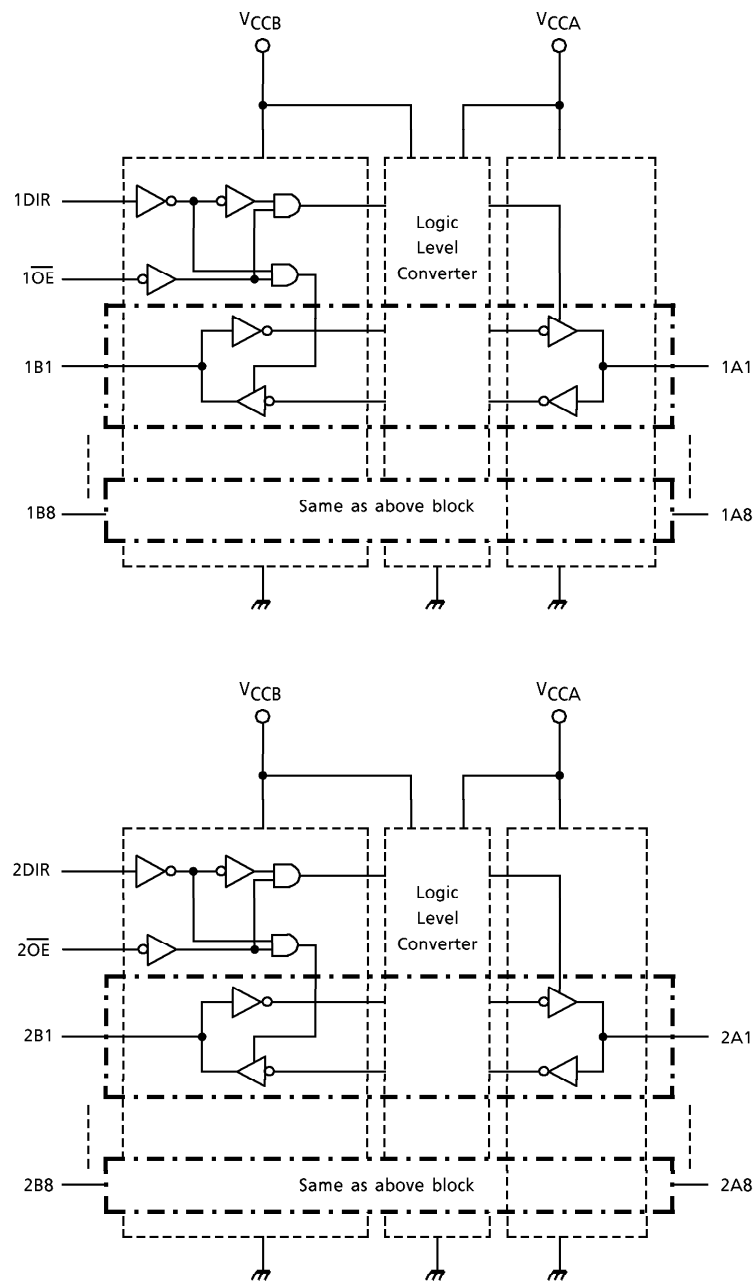
| INPUT |      | FUNCTION       |             | OUTPUT |
|-------|------|----------------|-------------|--------|
| 2OE   | 2DIR | BUS 2A1-2A8    | BUS 2B1-2B8 |        |
| L     | L    | OUTPUT         | INPUT       | A = B  |
| L     | H    | INPUT          | OUTPUT      | B = A  |
| H     | X    | High Impedance |             | Z      |

X : Don't Care  
Z : High impedance

980910EBA2'

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BLOCK DIAGRAM



## MAXIMUM RATINGS

| PARAMETER                                  | SYMBOL     | RATING                             | UNIT               |
|--------------------------------------------|------------|------------------------------------|--------------------|
| Power Supply Voltage<br>(Note 1)           | $V_{CCB}$  | $-0.5 \sim 7.0$                    | V                  |
|                                            | $V_{CCA}$  | $-0.5 \sim 7.0$                    |                    |
| DC Input Voltage                           | $V_{IN}$   | $-0.5 \sim 7.0$                    | V                  |
| DC Bus I/O Voltage                         | $V_I / OB$ | $-0.5 \sim 7.0$ (Note 3)           | V                  |
|                                            |            | $-0.5 \sim V_{CCB} + 0.5$ (Note 4) |                    |
|                                            | $V_I / OA$ | $-0.5 \sim 7.0$ (Note 3)           |                    |
|                                            |            | $-0.5 \sim V_{CCA} + 0.5$ (Note 4) |                    |
| Input Diode Current                        | $I_{IK}$   | $-50$                              | mA                 |
| Output Diode Current                       | $I_{I/OK}$ | $\pm 50$ (Note 5)                  | mA                 |
| DC Output Current                          | $I_{OUTB}$ | $\pm 50$                           | mA                 |
|                                            | $I_{OUTA}$ | $\pm 50$                           |                    |
| DC $V_{CC}$ /Ground Current Per Supply Pin | $I_{CCB}$  | $\pm 100$                          | mA                 |
|                                            | $I_{CCA}$  | $\pm 100$                          |                    |
| Power Dissipation                          | $P_D$      | 400                                | mW                 |
| Storage Temperature                        | $T_{stg}$  | $-65 \sim 150$                     | $^{\circ}\text{C}$ |

(Note 3) : Don't supply a voltage to  $V_{CCA}$  terminal when  $V_{CCB}$  is in the off-state.

(Note 4) : Off-State

(Note 5) : High or Low State.  $I_{OUT}$  absolute maximum rating must be observed.

(Note 6) :  $V_{OUT} < \text{GND}$ ,  $V_{OUT} > V_{CC}$

## RECOMMENDED OPERATING RANGE

| PARAMETER                             | SYMBOL     | RATING                                      | UNIT               |
|---------------------------------------|------------|---------------------------------------------|--------------------|
| Supply Voltage                        | $V_{CCB}$  | 2.3~3.6                                     | V                  |
|                                       | $V_{CCA}$  | 4.5~5.5                                     |                    |
| Input Voltage (DIR, $\overline{OE}$ ) | $V_{IN}$   | 0~5.5                                       | V                  |
| Bus I/O Voltage                       | $V_I / OB$ | 0~5.5 (Note 7)                              | V                  |
|                                       |            | 0~ $V_{CCB}$ (Note 8)                       |                    |
|                                       | $V_I / OA$ | 0~5.5 (Note 7)                              |                    |
|                                       |            | 0~ $V_{CCA}$ (Note 8)                       |                    |
| Output Current                        | $I_{OUTB}$ | $\pm 12$ (Note 9)                           | mA                 |
|                                       |            | $\pm 4$ (Note 10)                           |                    |
|                                       | $I_{OUTA}$ | $\pm 12$ (Note 11)                          |                    |
| Operating Temperature                 | $T_{opr}$  | $-40 \sim 85$                               | $^{\circ}\text{C}$ |
| Input Rise and Fall Time              | $dt/dv$    | 0~10 ( $V_{CCB} = 2.3 \sim 3.6 \text{ V}$ ) | ns/V               |
|                                       |            | 0~10 ( $V_{CCA} = 4.5 \sim 5.5 \text{ V}$ ) |                    |

(Note 7) : Off-State

(Note 8) : High or Low State

(Note 9) :  $V_{CCB} = 3.0 \sim 3.6 \text{ V}$

(Note 10) :  $V_{CCB} = 2.3 \sim 2.7 \text{ V}$

(Note 11) :  $V_{CCA} = 4.5 \sim 5.5 \text{ V}$

## ELECTRICAL CHARACTERISTICS

## DC Characteristics

| PARAMETER                        | SYM-<br>BOL       | TEST CONDITION                                                                                                                                    |                                                                                     | V <sub>CCB</sub><br>(V) | V <sub>CCA</sub><br>(V) | Ta = -40~85°C          |      | UNIT |
|----------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------|-------------------------|------------------------|------|------|
|                                  |                   |                                                                                                                                                   |                                                                                     |                         |                         | MIN                    | MAX  |      |
| “H” Level Input Voltage          | V <sub>IHB</sub>  | DIR, $\overline{OE}$ , Bn                                                                                                                         |                                                                                     | 2.5 ± 0.2               | 5.0 ± 0.5               | 1.7                    | —    | V    |
|                                  |                   |                                                                                                                                                   |                                                                                     | 3.3 ± 0.3               | 5.0 ± 0.5               | 2.0                    | —    |      |
|                                  | V <sub>IHA</sub>  | An                                                                                                                                                |                                                                                     | 2.3~3.6                 | 5.0 ± 0.5               | 2.0                    | —    |      |
| “L” Level Input Voltage          | V <sub>ILB</sub>  | DIR, $\overline{OE}$ , Bn                                                                                                                         |                                                                                     | 2.5 ± 0.2               | 5.0 ± 0.5               | —                      | 0.7  | V    |
|                                  |                   |                                                                                                                                                   |                                                                                     | 3.3 ± 0.3               | 5.0 ± 0.5               | —                      | 0.8  |      |
|                                  | V <sub>ILA</sub>  | An                                                                                                                                                |                                                                                     | 2.3~3.6                 | 5.0 ± 0.5               | —                      | 0.8  |      |
| “H” Level Output Voltage         | V <sub>OHB</sub>  | V <sub>IHA</sub> = V <sub>IHA</sub><br>or V <sub>ILA</sub><br>V <sub>INB</sub> = V <sub>IHB</sub><br>or V <sub>ILB</sub>                          | I <sub>OHB</sub> = -100 μA<br>I <sub>OHB</sub> = -12 mA<br>I <sub>OHB</sub> = -4 mA | 2.3~3.6                 | 5.0 ± 0.5               | V <sub>CCB</sub> - 0.2 | —    | V    |
|                                  |                   |                                                                                                                                                   |                                                                                     | 3.0                     | 5.0 ± 0.5               | 2.2                    | —    |      |
|                                  |                   |                                                                                                                                                   |                                                                                     | 2.3                     | 5.0 ± 0.5               | 1.8                    | —    |      |
|                                  | V <sub>OHA</sub>  |                                                                                                                                                   | I <sub>OHA</sub> = -100 μA<br>I <sub>OHA</sub> = -12 mA                             | 2.3~3.6                 | 5.0 ± 0.5               | V <sub>CCA</sub> - 0.2 | —    |      |
|                                  |                   |                                                                                                                                                   |                                                                                     | 2.3~3.6                 | 4.5                     | 3.7                    | —    |      |
|                                  |                   |                                                                                                                                                   |                                                                                     |                         |                         |                        |      |      |
| “L” Level Output Voltage         | V <sub>OLB</sub>  | V <sub>IHA</sub> = V <sub>IHA</sub><br>or V <sub>ILA</sub><br>V <sub>INB</sub> = V <sub>IHB</sub><br>or V <sub>ILB</sub>                          | I <sub>OHB</sub> = 100 μA<br>I <sub>OHB</sub> = 12 mA<br>I <sub>OHB</sub> = 4 mA    | 2.3~3.6                 | 5.0 ± 0.5               | —                      | 0.2  | V    |
|                                  |                   |                                                                                                                                                   |                                                                                     | 3.0                     | 5.0 ± 0.5               | —                      | 0.8  |      |
|                                  |                   |                                                                                                                                                   |                                                                                     | 2.3                     | 5.0 ± 0.5               | —                      | 0.6  |      |
|                                  | V <sub>OLA</sub>  |                                                                                                                                                   | I <sub>OHA</sub> = 100 μA<br>I <sub>OHA</sub> = 12 mA                               | 2.3~3.6                 | 5.0 ± 0.5               | —                      | 0.2  |      |
|                                  |                   |                                                                                                                                                   |                                                                                     | 2.3~3.6                 | 4.5                     | —                      | 0.7  |      |
|                                  |                   |                                                                                                                                                   |                                                                                     |                         |                         |                        |      |      |
| 3-State Output Off-State Current | I <sub>OZB</sub>  | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>L</sub><br>V <sub>I/OB</sub> = V <sub>CCB</sub> or GND                                                |                                                                                     | 2.3~3.6                 | 5.0 ± 0.5               | —                      | ±5.0 | μA   |
|                                  | I <sub>OZA</sub>  | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>L</sub><br>V <sub>I/OA</sub> = V <sub>CCA</sub> or GND                                                |                                                                                     | 2.3~3.6                 | 5.0 ± 0.5               | —                      | ±5.0 |      |
| Input Leakage Current            | I <sub>IN</sub>   | V <sub>IN</sub> (DIR, $\overline{OE}$ ) = V <sub>CCB</sub> or GND                                                                                 |                                                                                     | 3.6                     | 5.5                     | —                      | ±5.0 | μA   |
| Power Off Leakage Current        | I <sub>OFF</sub>  | V <sub>INA</sub> , V <sub>INB</sub> = 0~5.5 V                                                                                                     |                                                                                     | 0                       | 0                       | —                      | 10   | μA   |
| Quiescent Supply Current         | I <sub>CCB1</sub> | V <sub>I/OA</sub> = Open, V <sub>CCA</sub> = Open<br>V <sub>INB</sub> = V <sub>CCB</sub> or GND<br>$\overline{OE}$ = V <sub>CCB</sub> , DIR = GND |                                                                                     | 3.6                     | Open                    | —                      | 50   | μA   |
|                                  | I <sub>CCB2</sub> | V <sub>INA</sub> = V <sub>CCA</sub> or GND<br>V <sub>INB</sub> = V <sub>CCB</sub> or GND                                                          |                                                                                     | 3.6                     | 5.5                     | —                      | 50   |      |
|                                  | I <sub>CCA</sub>  | V <sub>INA</sub> = V <sub>CCA</sub> or GND<br>V <sub>INB</sub> = V <sub>CCB</sub> or GND                                                          |                                                                                     | 3.6                     | 5.5                     | —                      | 80   |      |
|                                  | I <sub>CCTB</sub> | V <sub>INB</sub> = V <sub>CCB</sub> - 0.6 V<br>PER INPUT                                                                                          |                                                                                     | 3.6                     | 5.0 ± 0.5               | —                      | 500  |      |
|                                  | I <sub>CCTA</sub> | V <sub>INA</sub> = 3.4 V<br>PER INPUT                                                                                                             |                                                                                     | 2.3~3.6                 | 5.5                     | —                      | 2.0  | mA   |

AC Characteristics (Input  $t_r = t_f = 2.5 \text{ ns}$ ,  $R_L = 500 \Omega$ )  
 $V_{CCB} = 3.3 \pm 0.3 \text{ V}$

| PARAMETER                                                        | SYMBOL                   | TEST CONDITION                           | CL<br>(pF) | V <sub>CCA</sub><br>(V) | Ta = -40~85°C |     | UNIT |
|------------------------------------------------------------------|--------------------------|------------------------------------------|------------|-------------------------|---------------|-----|------|
|                                                                  |                          |                                          |            |                         | MIN           | MAX |      |
| Propagation Delay<br>Time (Bn $\Rightarrow$ An)                  | $t_{pLH}$<br>$t_{pHL}$   | Input : Bn<br>Ouptut : An<br>(DIR = "L") | 50         | $5.0 \pm 0.5$           | 1.0           | 7.5 | ns   |
| 3-State Output Enable<br>Time ( $\overline{OE} \Rightarrow$ An)  | $t_{pZL}$<br>$t_{pZH}$   |                                          | 50         | $5.0 \pm 0.5$           | 1.0           | 9.5 |      |
| 3-State Output Disable<br>Time ( $\overline{OE} \Rightarrow$ An) | $t_{pLZ}$<br>$t_{pHZ}$   |                                          | 50         | $5.0 \pm 0.5$           | 1.0           | 9.5 |      |
| Propagation Delay<br>Time (An $\Rightarrow$ Bn)                  | $t_{pLH}$<br>$t_{pHL}$   | Input : An<br>Ouptut : Bn<br>(DIR = "H") | 50         | $5.0 \pm 0.5$           | 1.0           | 8.5 | ns   |
| 3-State Output Enable<br>Time ( $\overline{OE} \Rightarrow$ Bn)  | $t_{pZL}$<br>$t_{pZH}$   |                                          | 50         | $5.0 \pm 0.5$           | 1.0           | 9.5 |      |
| 3-State Output Disable<br>Time ( $\overline{OE} \Rightarrow$ Bn) | $t_{pLZ}$<br>$t_{pHZ}$   |                                          | 50         | $5.0 \pm 0.5$           | 1.0           | 9.5 |      |
| Output to Output<br>Skew                                         | $t_{osLH}$<br>$t_{osHL}$ | (Note 12)                                | 50         | $5.0 \pm 0.5$           | —             | 1.0 | ns   |

$V_{CCB} = 2.5 \pm 0.2 \text{ V}$

| PARAMETER                                                        | SYMBOL                   | TEST CONDITION                           | CL<br>(pF) | V <sub>CCA</sub><br>(V) | Ta = -40~85°C |      | UNIT |
|------------------------------------------------------------------|--------------------------|------------------------------------------|------------|-------------------------|---------------|------|------|
|                                                                  |                          |                                          |            |                         | MIN           | MAX  |      |
| Propagation Delay<br>Time (Bn $\Rightarrow$ An)                  | $t_{pLH}$<br>$t_{pHL}$   | Input : Bn<br>Ouptut : An<br>(DIR = "L") | 50         | $5.0 \pm 0.5$           | 1.0           | 9.0  | ns   |
| 3-State Output Enable<br>Time ( $\overline{OE} \Rightarrow$ An)  | $t_{pZL}$<br>$t_{pZH}$   |                                          | 50         | $5.0 \pm 0.5$           | 1.0           | 13.0 |      |
| 3-State Output Disable<br>Time ( $\overline{OE} \Rightarrow$ An) | $t_{pLZ}$<br>$t_{pHZ}$   |                                          | 50         | $5.0 \pm 0.5$           | 1.0           | 14.0 |      |
| Propagation Delay<br>Time (An $\Rightarrow$ Bn)                  | $t_{pLH}$<br>$t_{pHL}$   | Input : An<br>Ouptut : Bn<br>(DIR = "H") | 30         | $5.0 \pm 0.5$           | 1.0           | 9.5  | ns   |
| 3-State Output Enable<br>Time ( $\overline{OE} \Rightarrow$ Bn)  | $t_{pZL}$<br>$t_{pZH}$   |                                          | 30         | $5.0 \pm 0.5$           | 1.0           | 12.5 |      |
| 3-State Output Disable<br>Time ( $\overline{OE} \Rightarrow$ Bn) | $t_{pLZ}$<br>$t_{pHZ}$   |                                          | 30         | $5.0 \pm 0.5$           | 1.0           | 10.0 |      |
| Output to Output<br>Skew                                         | $t_{osLH}$<br>$t_{osHL}$ | (Note 12)                                | 30 or 50   | $5.0 \pm 0.5$           | —             | 1.0  | ns   |

(Note 12) : Parameter guaranteed by design.  
 $(t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|)$

Capacitive characteristics (Ta = 25°C)

V<sub>CCB</sub> = 2.5, 3.3 V

| PARAMETER                                  | SYMBOL           | TEST CONDITION                | V <sub>CCA</sub> (V) | TYP. | UNIT |
|--------------------------------------------|------------------|-------------------------------|----------------------|------|------|
|                                            |                  |                               |                      |      |      |
| Input Capacitance                          | C <sub>IN</sub>  | DIR, $\overline{\text{OE}}$   | 5.0                  | 7    | pF   |
| Output Capacitance                         | C <sub>I/O</sub> | An, Bn                        | 5.0                  | 8    | pF   |
| Power Dissipation Capacitance<br>(Note 13) | C <sub>PDA</sub> | A $\Rightarrow$ B (DIR = "H") | 5.0                  | 20   | pF   |
|                                            |                  | B $\Rightarrow$ A (DIR = "L") | 5.0                  | 66   |      |
|                                            | C <sub>PDB</sub> | A $\Rightarrow$ B (DIR = "H") | 5.0                  | 34   |      |
|                                            |                  | B $\Rightarrow$ A (DIR = "L") | 5.0                  | 4    |      |

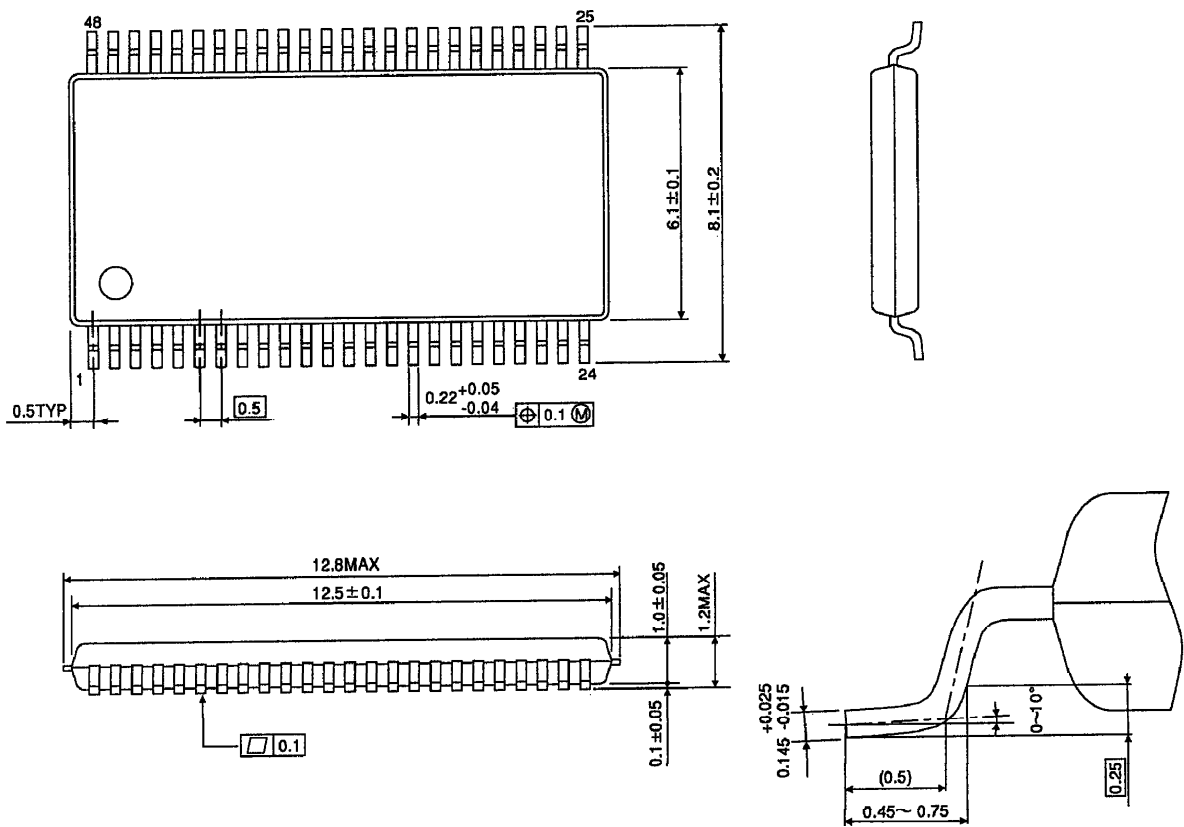
(Note 13) : C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

$$I_{CC}(\text{opr.}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC} / 16 \text{ (per bit)}$$

PACKAGE DIMENSIONS  
TSSOP48-P-0061-0.50

Unit : mm



Weight : 0.25 g (Typ.)