

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

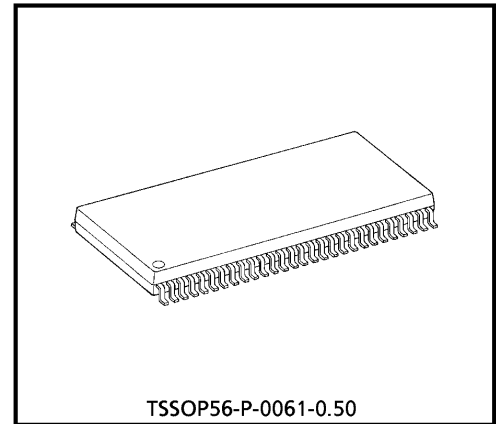
TC74VCXR162543FT**LOW-VOLTAGE 16-BIT REGISTERED TRANSCEIVER WITH 3.6 V
TOLERANT INPUTS AND OUTPUTS**

The TC74VCXR162543FT is a high performance CMOS 16-bit REGISTERED TRANSCEIVER. Designed for use in 1.8, 2.5 or 3.3 Volt systems, it achieves high speed operation while maintaining the CMOS low power dissipation. It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

The TC74VCXR162543FT can be used as two 8-bit transceivers or one 16-bit transceiver. Separate latch-enable (LEAB or LEBA) and output-enable (OEAB or OEBA) inputs are provided for each register to permit independent control in either direction of data flow. The A-to-B enable (\overline{CEAB}) input must be low in order to enter data from A or to output data from B. If \overline{CEAB} is low and \overline{LEAB} is low, the A-to-B latches are transparent; a subsequent low-to-high transition of \overline{LEAB} puts the A latches in the storage mode. With \overline{CEAB} and \overline{OEAB} both low, the 3-state B outputs are active and reflect the data present at the output of the A latches. Data flow from B to A is similar but requires using the \overline{CEBA} , \overline{LEBA} , and \overline{OEBA} inputs.

When the \overline{OE} input is high, the outputs are in a high impedance state. This device is designed to be used with 3-state memory address drivers, etc.

The 26- Ω series resistor helps reducing output overshoot and undershoot without external resistor. All inputs are equipped with protection circuits against static discharge.



Weight : 0.25 g (Typ.)

FEATURES

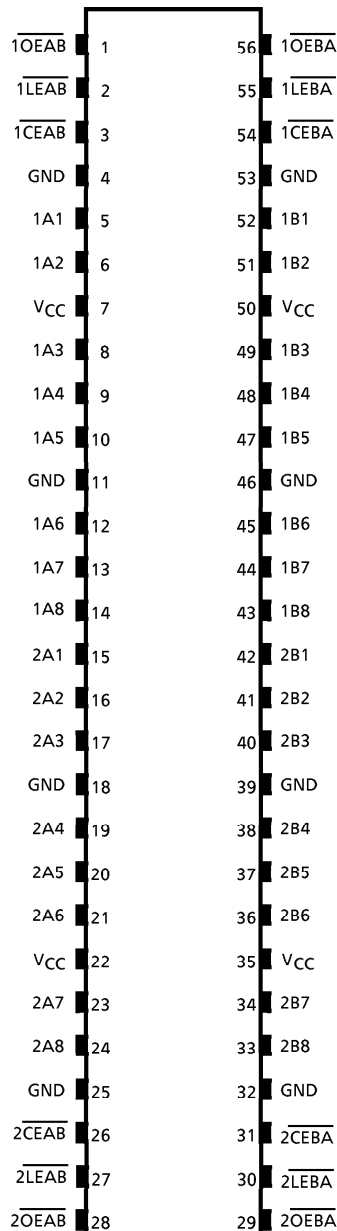
- 26- Ω Series Resistors on Outputs.
- Low Voltage Operation : $V_{CC} = 1.8\sim 3.6\text{ V}$
- High Speed Operation : $t_{pd} = 4.4\text{ ns (max) at } V_{CC} = 3.0\sim 3.6\text{ V}$
 : $t_{pd} = 5.4\text{ ns (max) at } V_{CC} = 2.3\sim 2.7\text{ V}$
 : $t_{pd} = 9.8\text{ ns (max) at } V_{CC} = 1.8\text{ V}$
- 3.6 V Tolerant inputs and outputs.
- Output Current : $I_{OH}/I_{OL} = \pm 12\text{ mA (min) at } V_{CC} = 3.0\text{ V}$
 : $I_{OH}/I_{OL} = \pm 8\text{ mA (min) at } V_{CC} = 2.3\text{ V}$
 : $I_{OH}/I_{OL} = \pm 4\text{ mA (min) at } V_{CC} = 1.8\text{ V}$
- Latch-up Performance : $\pm 300\text{ mA}$
- ESD Performance : Human Body Model $> \pm 2000\text{ V}$
 : Machine Model $> \pm 200\text{ V}$
- Package : TSSOP
 (Thin Shrink Small Outline Package)
- Power Down Protection is provided on all inputs and outputs.
- Supports live insertion / withdrawal (Note 3).

980910EBA2

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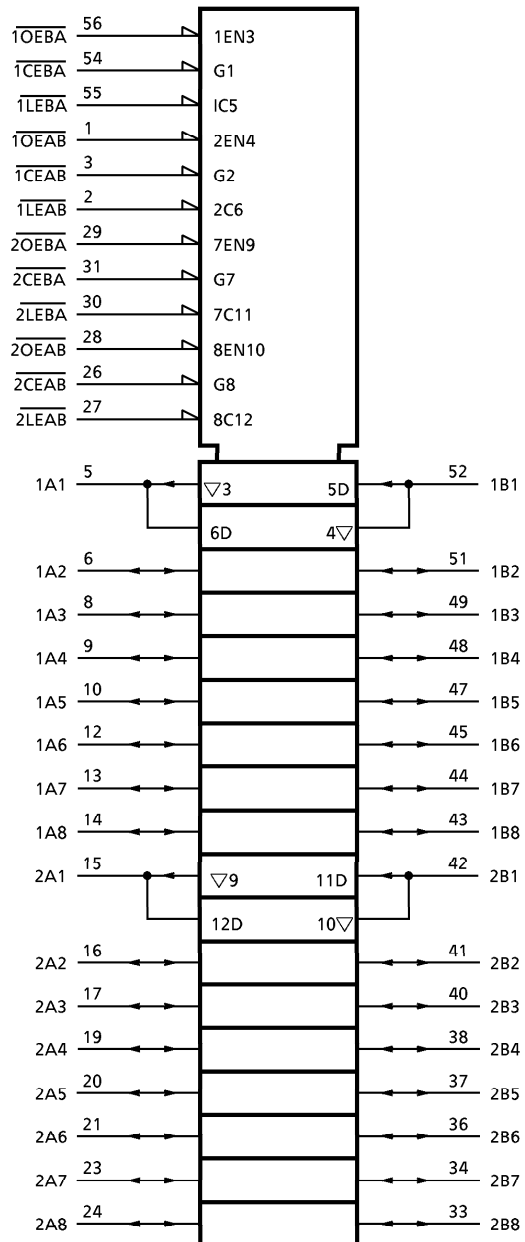
- (Note 1) : Do not apply a signal to any bus terminal when it is in the output mode. Damage may result.
- (Note 2) : All floating (high impedance) bus terminal must have their input level fixed by means of pull up or pull down resistors.
- (Note 3) : To ensure the high-impedance state during power up or power down, \overline{OE} should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

PIN ASSIGNMENT



(TOP VIEW)

SYMBOL



980910EBA2'

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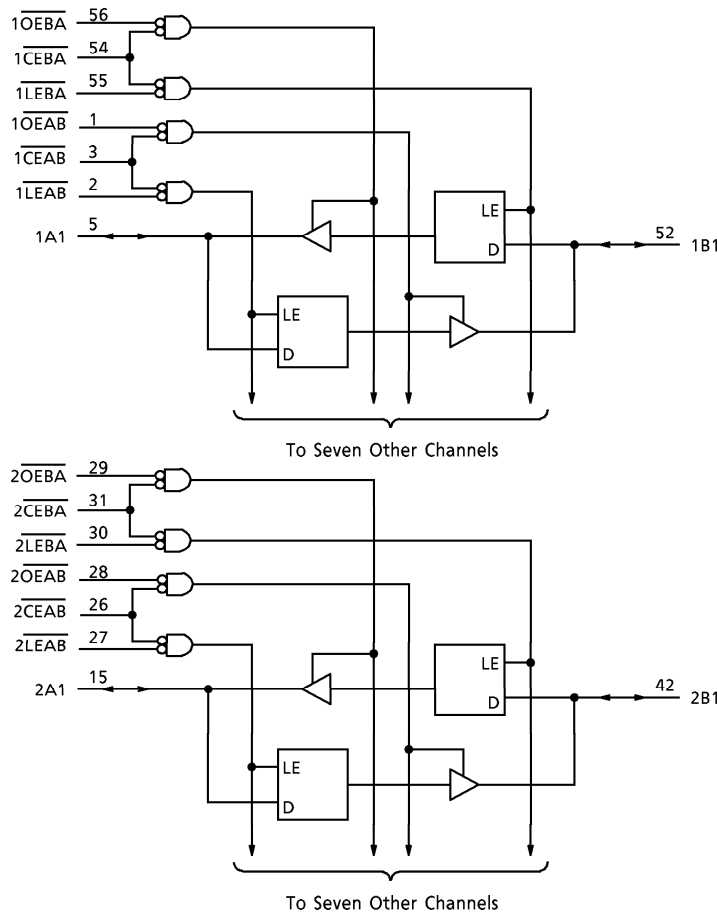
FUNCTION TABLE* (each 8-bit latch)

| INPUTS | | | | OUTPUTS |
|-------------------|-------------------|-------------------|---|------------|
| \overline{CEAB} | \overline{LEAB} | \overline{OEAB} | A | B |
| H | X | X | X | Z |
| X | X | H | X | Z |
| L | H | L | X | B_0^{**} |
| L | L | L | L | L |
| L | L | L | H | H |

* A-to-B data flow is shown; B-to-A flow control is the same except that it uses \overline{CEBA} , \overline{LEBA} , and \overline{OEBA} .

** Output level before the indicated steady-state input conditions were established.

SYSTEM DIAGRAM



MAXIMUM RATINGS

| PARAMETER | SYMBOL | RATING | UNIT |
|---|--------------------|-------------------------------|-------------|
| Power Supply Voltage | V_{CC} | -0.5~4.6 | V |
| DC Input Voltage (\overline{OEAB} , \overline{OEBA} , \overline{LEAB} , \overline{LEBA} , \overline{CEAB} , \overline{CEBA}) | V_{IN} | -0.5~4.6 | V |
| DC Bus I/O Voltage | $V_{I/O}$ | -0.5~4.6 (Note 1) | V |
| | | -0.5~ V_{CC} + 0.5 (Note 2) | |
| Input Diode Current | I_{IK} | -50 | mA |
| Output Diode Current | I_{OK} | ± 50 (Note 3) | mA |
| DC Output Current | I_{OUT} | ± 50 | mA |
| Power Dissipation | P_D | 400 | mW |
| DC V_{CC} / Ground Current Per Supply Pin | I_{CC} / I_{GND} | ± 100 | mA |
| Storage Temperature | T_{stg} | -65~150 | $^{\circ}C$ |

(Note 1) : Off-State

(Note 2) : High or Low State. I_{OUT} absolute maximum rating must be observed.

(Note 3) : $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

RECOMMENDED OPERATING RANGE

| PARAMETER | SYMBOL | RATING | UNIT |
|--|-------------------|----------------------|-------------|
| Supply Voltage | V_{CC} | 1.8~3.6 | V |
| | | 1.2~3.6 (Note 4) | |
| Input Voltage (\overline{OEAB} , \overline{OEBA} , \overline{LEAB} , \overline{LEBA} , \overline{CEAB} , \overline{CEBA}) | V_{IN} | -0.3~3.6 | V |
| Bus I/O Voltage | $V_{I/O}$ | 0~3.6 (Note 5) | V |
| | | 0~ V_{CC} (Note 6) | |
| Output Current | I_{OH} / I_{OL} | ± 12 (Note 7) | mA |
| | | ± 8 (Note 8) | |
| | | ± 4 (Note 9) | |
| Operating Temperature | T_{opr} | -40~85 | $^{\circ}C$ |
| Input Rise And Fall Time | dt / dv | 0~10 (Note 10) | ns/V |

(Note 4) : Data Retention Only

(Note 5) : Off-State

(Note 6) : High or Low State

(Note 7) : $V_{CC} = 3.0 \sim 3.6 V$

(Note 8) : $V_{CC} = 2.3 \sim 2.7 V$

(Note 9) : $V_{CC} = 1.8 V$

(Note 10) : $V_{IN} = 0.8 \sim 2.0 V$, $V_{CC} = 3.0 V$

ELECTRICAL CHARACTERISTICS

DC characteristics (Ta = -40~85°C, 2.7 V < V_{CC} ≤ 3.6 V)

| PARAMETER | | SYMBOL | TEST CONDITION | | V _{CC} (V) | MIN | MAX | UNIT |
|---------------------------------------|-----------|------------------|--|---------------------------|---------------------|-----------------------|--------|------|
| | | | | | | | | |
| Input Voltage | "H" Level | V _{IH} | | | 2.7~3.6 | 2.0 | — | V |
| | "L" Level | V _{IL} | | | 2.7~3.6 | — | 0.8 | V |
| Output Voltage | "H" Level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 2.7~3.6 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -6 mA | 2.7 | 2.2 | — | |
| | | | | I _{OH} = -8 mA | 3.0 | 2.4 | — | |
| | | | | I _{OH} = -12 mA | 3.0 | 2.2 | — | |
| | "L" Level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 2.7~3.6 | — | 0.2 | V |
| | | | | I _{OL} = 6 mA | 2.7 | — | 0.4 | |
| | | | | I _{OL} = 8 mA | 3.0 | — | 0.55 | |
| | | | | I _{OL} = 12 mA | 3.0 | — | 0.8 | |
| Input Leakage Current | | I _{IN} | V _{IN} = 0~3.6 V | | 2.7~3.6 | — | ± 5.0 | μA |
| 3-State Output Off-State Current | | I _{OZ} | V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V | | 2.7~3.6 | — | ± 10.0 | μA |
| Power Off Leakage Current | | I _{OFF} | V _{IN} , V _{OUT} = 0~3.6 V | | 0 | — | 10.0 | μA |
| Quiescent Supply Current | | I _{CC} | V _{IN} = V _{CC} or GND | | 2.7~3.6 | — | 20.0 | μA |
| | | | V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V | | 2.7~3.6 | — | ± 20.0 | |
| Increase In I _{CC} Per Input | | ΔI _{CC} | V _{IH} = V _{CC} - 0.6 V | | 2.7~3.6 | — | 750 | μA |

ELECTRICAL CHARACTERISTICS

DC characteristics (Ta = -40~85°C, 2.3 V ≤ V_{CC} ≤ 2.7 V)

| PARAMETER | | SYMBOL | TEST CONDITION | | V _{CC} (V) | MIN | MAX | UNIT |
|----------------------------------|-----------|------------------|--|---------------------------|---------------------|-----------------------|--------|------|
| | | | | | | | | |
| Input Voltage | "H" Level | V _{IH} | | | 2.3~2.7 | 1.6 | — | V |
| | "L" Level | V _{IL} | | | 2.3~2.7 | — | 0.7 | V |
| Output Voltage | "H" Level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 2.3~2.7 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -4 mA | 2.3 | 2.0 | — | |
| | | | | I _{OH} = -6 mA | 2.3 | 1.8 | — | |
| | | | | I _{OH} = -8 mA | 2.3 | 1.7 | — | |
| | "L" Level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 2.3~2.7 | — | 0.2 | V |
| | | | | I _{OL} = 6 mA | 2.3 | — | 0.4 | |
| | | | | I _{OL} = 8 mA | 2.3 | — | 0.6 | |
| | | | | | | | | |
| Input Leakage Current | | I _{IN} | V _{IN} = 0~3.6 V | | 2.3~2.7 | — | ± 5.0 | μA |
| 3-State Output Off-State Current | | I _{OZ} | V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V | | 2.3~2.7 | — | ± 10.0 | μA |
| Power Off Leakage Current | | I _{OFF} | V _{IN} , V _{OUT} = 0~3.6 V | | 0 | — | 10.0 | μA |
| Quiescent Supply Current | | I _{CC} | V _{IN} = V _{CC} or GND | | 2.3~2.7 | — | 20.0 | μA |
| | | | V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V | | 2.3~2.7 | — | ± 20.0 | |

ELECTRICAL CHARACTERISTICS

DC characteristics (Ta = -40~85°C, 1.8 V ≤ VCC < 2.3 V)

| PARAMETER | | SYMBOL | TEST CONDITION | | VCC (V) | MIN | MAX | UNIT |
|----------------------------------|-----------|------------------|--|---------------------------|---------|-----------------------|-----------------------|------|
| | | | | | | | | |
| Input Voltage | "H" Level | V _{IH} | | | 1.8~2.3 | 0.7 × V _{CC} | — | V |
| | "L" Level | V _{IL} | | | 1.8~2.3 | — | 0.2 × V _{CC} | V |
| Output Voltage | "H" Level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -100 μA | 1.8 | V _{CC} - 0.2 | — | V |
| | | | | I _{OH} = -4 mA | 1.8 | 1.4 | — | |
| | "L" Level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 100 μA | 1.8 | — | 0.2 | V |
| | | | | I _{OL} = 4 mA | 1.8 | — | 0.3 | |
| Input Leakage Current | | I _{IN} | V _{IN} = 0~3.6 V | | 1.8 | — | ± 5.0 | μA |
| 3-State Output Off-State Current | | I _{OZ} | V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0~3.6 V | | 1.8 | — | ± 10.0 | μA |
| Power Off Leakage Current | | I _{OFF} | V _{IN} , V _{OUT} = 0~3.6 V | | 0 | — | 10.0 | μA |
| Quiescent Supply Current | | I _{CC} | V _{IN} = V _{CC} or GND | | 1.8 | — | 20.0 | μA |
| | | | V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V | | 1.8 | — | ± 20.0 | |

AC characteristics (Ta = -40~85°C, Input tr = tf = 2.0 ns, CL = 30 pF, RL = 500 Ω)

| PARAMETER | SYMBOL | TEST CONDITION | VCC (V) | MIN | MAX | UNIT |
|--|----------------|----------------|-----------|-----|-----|------|
| | | | | | | |
| Propagation Delay Time (An, Bn-Bn, An) | tpLH tpHL | (Fig.1, 2) | 1.8 | 1.5 | 9.8 | ns |
| | | | 2.5 ± 0.2 | 0.8 | 5.4 | |
| | | | 3.3 ± 0.3 | 0.6 | 4.4 | |
| Propagation Delay Time (LEAB, LEBA-Bn, An) | tpLH tpHL | (Fig.1, 2) | 1.8 | 1.5 | 9.8 | ns |
| | | | 2.5 ± 0.2 | 0.8 | 6.4 | |
| | | | 3.3 ± 0.3 | 0.6 | 4.8 | |
| 3-State Output Enable Time (OEAB, OEBA, CEAB, CEBA) | tpZL tpZH | (Fig.1, 4) | 1.8 | 1.5 | 9.8 | ns |
| | | | 2.5 ± 0.2 | 0.8 | 5.9 | |
| | | | 3.3 ± 0.3 | 0.6 | 4.3 | |
| 3-State Output Disable Time (OEAB, OEBA, CEAB, CEBA) | tpLZ tpHZ | (Fig.1, 4) | 1.8 | 1.5 | 8.8 | ns |
| | | | 2.5 ± 0.2 | 0.8 | 4.9 | |
| | | | 3.3 ± 0.3 | 0.6 | 4.3 | |
| Minimum Pulse Width (LEAB, LEBA, CEAB, CEBA) | tw (L) | (Fig.1, 2, 3) | 1.8 | 4.0 | — | ns |
| | | | 2.5 ± 0.2 | 1.5 | — | |
| | | | 3.3 ± 0.3 | 1.5 | — | |
| Minimum Set-up Time (An, Bn-LE, CE) | ts | (Fig.1, 2, 3) | 1.8 | 2.5 | — | ns |
| | | | 2.5 ± 0.2 | 1.5 | — | |
| | | | 3.3 ± 0.3 | 1.5 | — | |
| Minimum Hold Time (An, Bn-LE, CE) | th | (Fig.1, 2, 3) | 1.8 | 1.0 | — | ns |
| | | | 2.5 ± 0.2 | 1.0 | — | |
| | | | 3.3 ± 0.3 | 1.0 | — | |
| Output to Output Skew | tosLH tosHL | (Note 11) | 1.8 | — | 0.5 | ns |
| | | | 2.5 ± 0.2 | — | 0.5 | |
| | | | 3.3 ± 0.3 | — | 0.5 | |

For CL = 50 pF, add approximately 300 ps to the AC maximum specification.

(Note 11) : Parameter guaranteed by design.

$$(tosLH = |tpLHm - tpLHn|, tosHL = |tpHLm - tpHLn|)$$

Dynamic switching characteristics (Ta = 25°C, Input $t_r = t_f = 2.0$ ns, $C_L = 30$ pF)

| PARAMETER | SYMBOL | TEST CONDITION | V _{CC} (V) | TYP. | UNIT |
|--|------------------|--|---------------------|-------|------|
| | | | | | |
| Quiet Output Maximum Dynamic V _{OL} | V _{OLP} | V _{IH} = 1.8 V, V _{IL} = 0 V (Note 12) | 1.8 | 0.15 | V |
| | | V _{IH} = 2.5 V, V _{IL} = 0 V (Note 12) | 2.5 | 0.25 | |
| | | V _{IH} = 3.3 V, V _{IL} = 0 V (Note 12) | 3.3 | 0.35 | |
| Quiet Output Minimum Dynamic V _{OL} | V _{OLV} | V _{IH} = 1.8 V, V _{IL} = 0 V (Note 12) | 1.8 | -0.15 | V |
| | | V _{IH} = 2.5 V, V _{IL} = 0 V (Note 12) | 2.5 | -0.25 | |
| | | V _{IH} = 3.3 V, V _{IL} = 0 V (Note 12) | 3.3 | -0.35 | |
| Quiet Output Minimum Dynamic V _{OH} | V _{OHV} | V _{IH} = 1.8 V, V _{IL} = 0 V (Note 12) | 1.8 | 1.55 | V |
| | | V _{IH} = 2.5 V, V _{IL} = 0 V (Note 12) | 2.5 | 2.05 | |
| | | V _{IH} = 3.3 V, V _{IL} = 0 V (Note 12) | 3.3 | 2.65 | |

(Note 12) : Parameter guaranteed by design.

Capacitive characteristics (Ta = 25°C)

| PARAMETER | SYMBOL | TEST CONDITION | V _{CC} (V) | TYP. | UNIT |
|-------------------------------|------------------|---------------------------------------|---------------------|------|------|
| | | | | | |
| Input Capacitance | C _{IN} | OEAB, OEBA, CEAB, CEBA, LEAB, LEBA | 1.8, 2.5, 3.3 | 6 | pF |
| Bus I/O Capacitance | C _{I/O} | — | 1.8, 2.5, 3.3 | 7 | pF |
| Power Dissipation Capacitance | C _{PD} | f _{IN} = 10 MHz (Note 13) | 1.8, 2.5, 3.3 | 20 | pF |

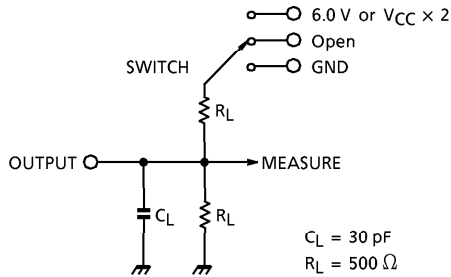
(Note 13) : C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

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

TEST CIRCUIT

Fig.1



| PARAMETER | SWITCH |
|--------------------|--|
| t_{pLH}, t_{pHL} | Open |
| t_{pLZ}, t_{pZL} | 6.0 V @ $V_{CC} = 3.3 \pm 0.3 \text{ V}$ $V_{CC} \times 2$ @ $V_{CC} = 2.5 \pm 0.2 \text{ V}$ @ $V_{CC} = 1.8 \text{ V}$ |
| t_{pHZ}, t_{pZH} | GND |

AC WAVEFORM

Fig.2 $t_{pLH}, t_{pHL}, t_w, t_s, t_h$

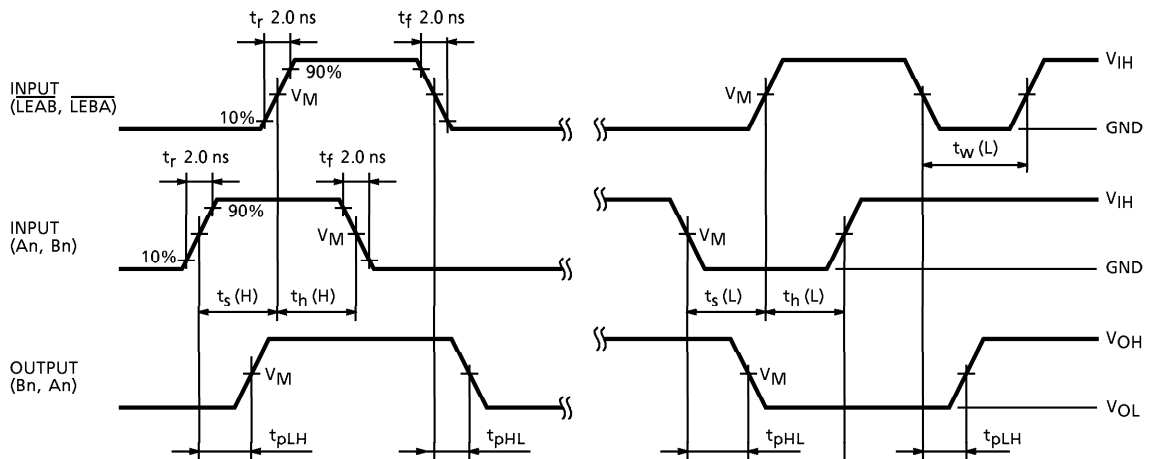


Fig.3 t_w, t_s, t_h

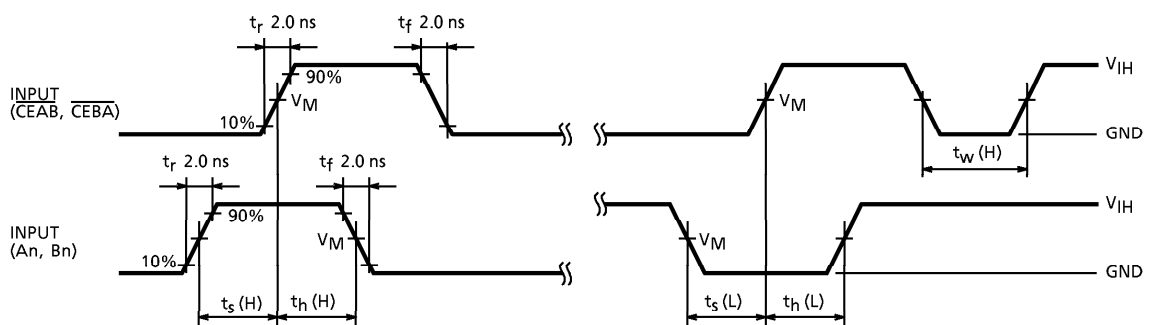
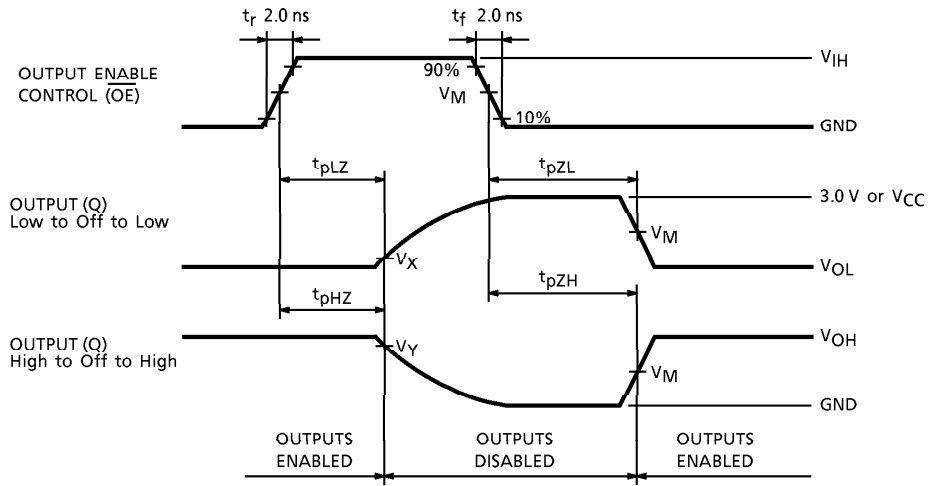


Fig.4 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

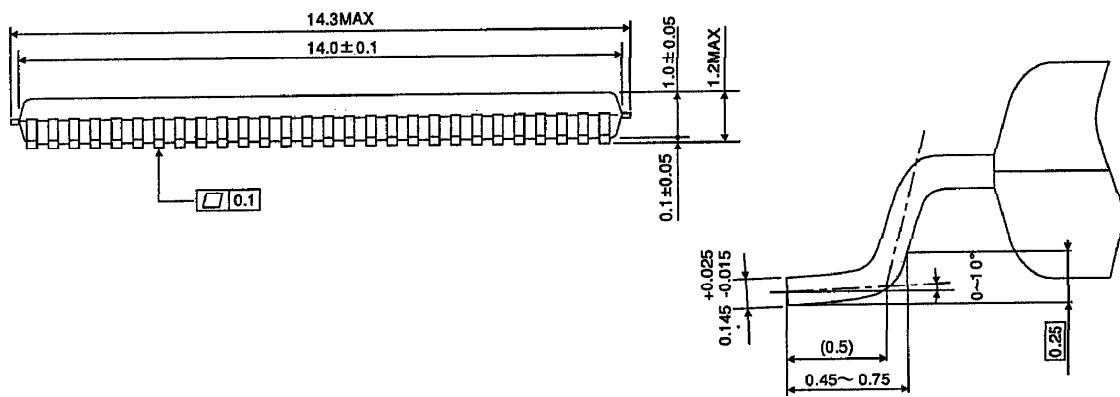
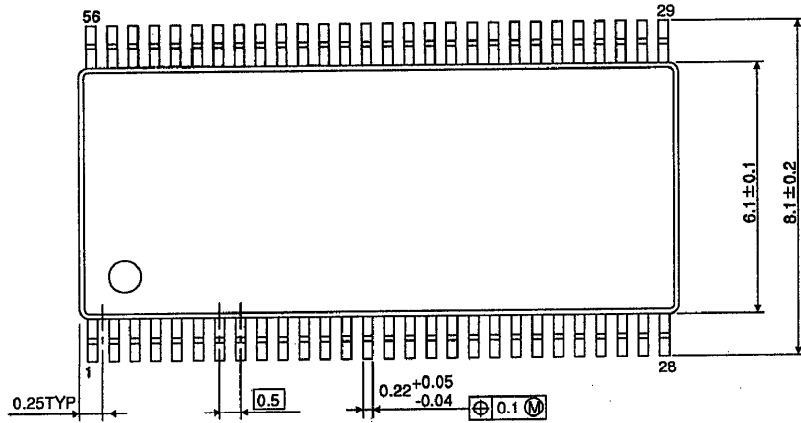


| SYMBOL | V_{CC} | | |
|----------|--------------------------|---------------------------|---------------------------|
| | $3.3 \pm 0.3 \text{ V}$ | $2.5 \pm 0.2 \text{ V}$ | 1.8 V |
| V_{IH} | 2.7 V | V_{CC} | V_{CC} |
| V_M | 1.5 V | $V_{CC} / 2$ | $V_{CC} / 2$ |
| V_X | $V_{OL} + 0.3 \text{ V}$ | $V_{OL} + 0.15 \text{ V}$ | $V_{OL} + 0.15 \text{ V}$ |
| V_Y | $V_{OH} - 0.3 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ | $V_{OH} - 0.15 \text{ V}$ |

PACKAGE DIMENSIONS

TSSOP56-P-0061-0.50

Unit : mm



Weight : 0.25 g (Typ.)